

Leonid Rozenblit and Frank Keil "The misunderstood limits of folk science: an illusion of explanatory depth."

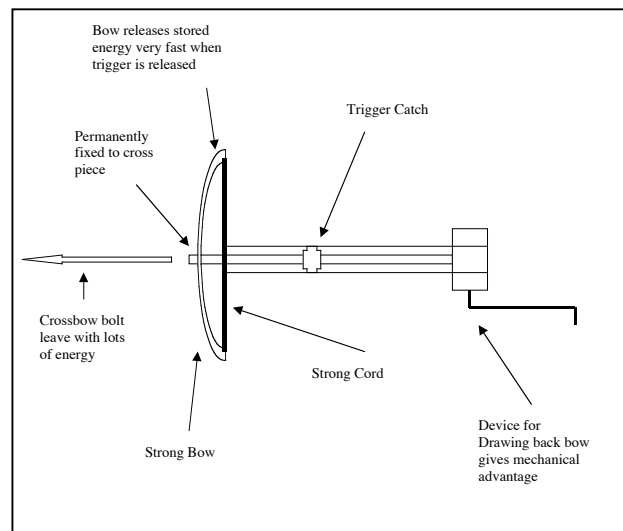
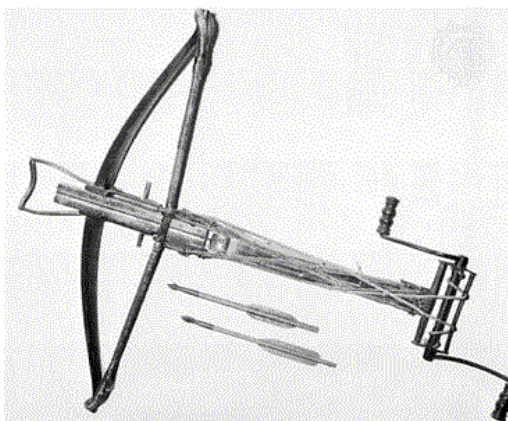
* Stimuli used in Studies 1-3: item-set A.

Subject Number	Gender	Major

Introduction

In this experiment you will rate how well you feel you understand how different things work. We'll ask you to rate your understanding on a seven-point scale. Before you get started, this introduction will try to explain what the scores on the scale are supposed to reflect.

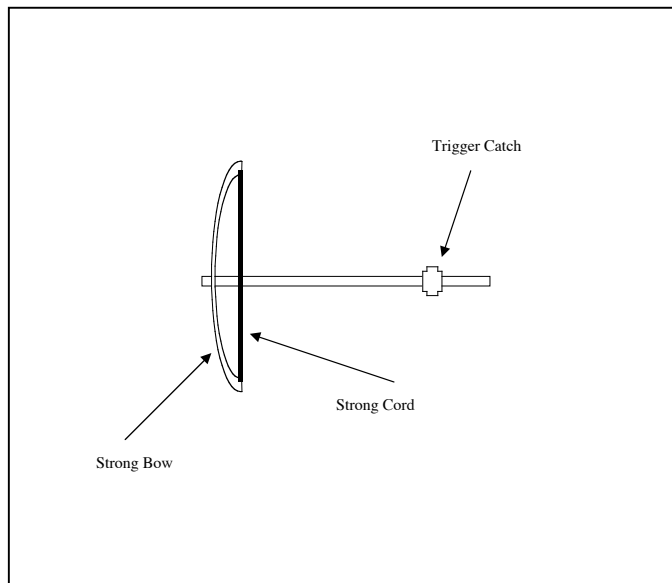
Some things are well-understood: almost everyone knows how and why they work. That is they can tell you about all the parts and how they work together. One such example might be the crossbow. Most people know how it works, e.g., that it has a stiff, flexible piece of metal as a bow with a wire or strong line; that the bow is permanently mounted on a block of wood or metal; that the wire is pulled back by something that gives a mechanical advantage, either a lever, or small block and tackle, or by a crank wound around a spool that pulls a wire attached to the bow wire. The bow wire is then held back by a pin that is connected to a trigger, and an arrow is set in front of it. Often the pin is forked so the arrow can sit directly in the wire. The pin is directly connected to the trigger so that when you pull on the trigger, it causes it to pivot around a point such that the end that is the pin moves downwards and releases the bow wire. When the pin releases the string, the bow very quickly un-flexes, rapidly imparting all the energy stored in the flexed bow to



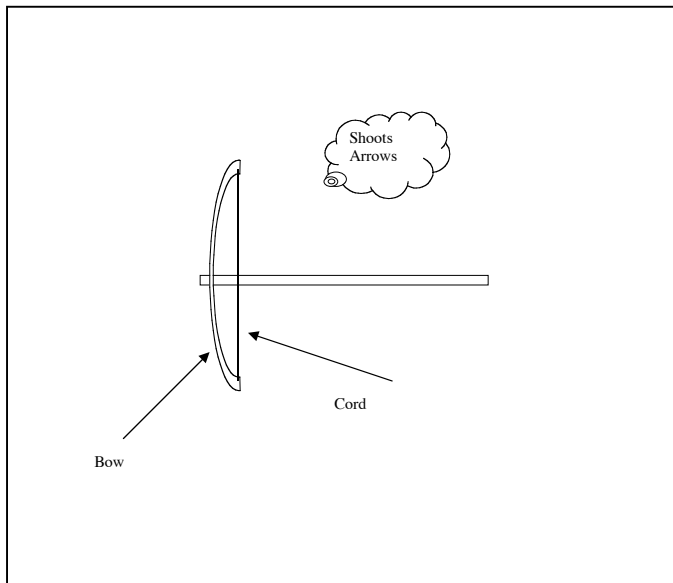
the arrow. (see the picture and diagram below).

So most people have a pretty good idea about how a crossbow works. A person who could draw the diagram above probably has a good understanding of crossbows.

Some people know less detail. For example, someone might know only that the crossbow is a fixed bow and arrow arrangement; that it gets more power than a normal bow and arrow because it allows you to pull the string back extra hard and then trap it there rather than hold it, and that it is then released by a trigger. If this person were to draw a diagram of a crossbow it might look like this.



Some people might know even less. For example, someone might really only know what a crossbow looks like and what it does -- shoots arrows. That person's understanding might be best represented by the following diagram, where the lack of important parts and labels indicate they really don't have any idea about the details.



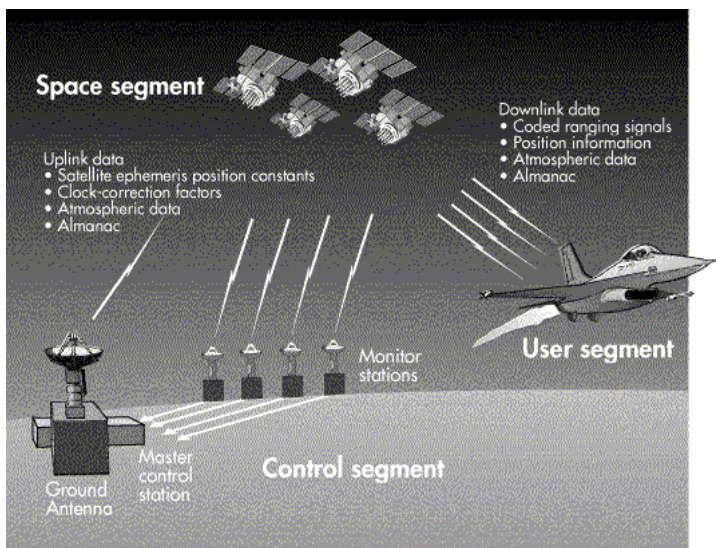
What we tried to demonstrate with the crossbow example is that you can think of knowledge about how things work as arranged along a continuum, which we can represent as a seven-point scale.

<1 2 3 4 5 6 7>

For the crossbow, many people are probably close to a 7, such as the hypothetical person who would draw the first crossbow diagram. Others are close to a 4, such as the hypothetical person who would draw the second crossbow diagram, and some, such as a person who would draw the third crossbow diagram, are close to a 1.

On the other hand, for something like a handheld GPS receiver, most people are probably closer to a 1, knowing only that this thing about the size of a TV remote control tells you where you are anywhere in the world with a high degree of precision. A person with level 3 knowledge might know that GPS handheld receivers get signals from satellites and that, depending on where the receiver is located on the earth, the signals from the satellites create different patterns, and some kind of computational stuff in the handheld receiver computes your position from that combined pattern. A person with level 7 knowledge of GPS receivers would know all about what those signals were, how they varied across different locations, and precisely what calculations the handheld receiver did.

Level 7 knowledge would involve knowing, for example, that the signal measures distance between the receiver and the satellite (by transmitting the exact time at which the signal was sent), and that a receiver measures signals from 4 satellites to compute position. A person with level-7 knowledge would also know why the satellites need ultra-accurate clocks; why knowing the speed of light is important to being able to determine position, why you need a signal from at least three satellites to determine your position exactly, and why the radio signals must be high-frequency. Level-7 knowledge might also involve knowing something about how the entire GPS system operates, e.g., that there are many GPS satellites, monitored by multiple ground stations, and controlled by a master control station (see diagram below).



Note that one does not need to be an expert to have level 7 knowledge – an intelligent, educated lay-person who has read and understood a good description of the phenomenon in an appropriate reference source probably has level 7 knowledge, as we define it. An expert in a particular phenomenon would almost necessarily have level 7 knowledge, since experts know more than even the most knowledgeable lay-people. Thus, our rating scale is not sensitive to degrees of

expert knowledge – the experts know so much they are “off the scale.” The 1-7 scale we described only measures levels of non-expert knowledge.

Instructions

We are trying to get a sense of how people feel about their understandings of various devices and natural phenomena as part of a larger study of how people make sense of the world. We are going to present you with 48 items; we want you to rate on a 7-point scale how well you feel you understand each one. The 7-point scale is based on the description above. That is, you should give the item close to a “7” if you feel your understanding of the item is like most people’s understanding of a crossbow, and close to a “1” if you feel your understanding is like most people’s understanding of a GPS handheld receiver.

There is one tricky part to keep in mind. Some of our participants get confused and think they are rating how well they feel they understand each phenomenon relative to how well other people understand that same phenomenon. **That’s not your task.** We only talked about what other people know about crossbows and GPS receivers to explain what the extremes of the scale mean. The 7 point scale is meant to be absolute – it does not depend on what you think others may know about each item. In other words, you will be rating how well you feel you understand each phenomena relative to all the other phenomena you know (like crossbows, GPS receivers, etc.). Remember, 7 means you have a very thorough understanding of a phenomenon, 1 means you have a very vague understanding of the phenomenon.

Finally, it’s very important to give us your **first impression.** We find that taking too long really hurts people’s answers. Please go through the list below as quickly as possible and circle the number from 1-7 on the scale next to each phenomenon, telling us how well you feel you understand each item.

Rating 1: Distracters & Test (Randomized)

Phenomena		Scale
How	a sewing machine works	< 1 2 3 4 5 6 7 >
How	an LCD Screen works	< 1 2 3 4 5 6 7 >
How	a can opener works	< 1 2 3 4 5 6 7 >
How	a 35mm camera (Single-Lens Reflex Camera) makes images on film	< 1 2 3 4 5 6 7 >
How	a zipper works	< 1 2 3 4 5 6 7 >
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How	a greenhouse works	< 1 2 3 4 5 6 7 >
How	a fluorescent light works	< 1 2 3 4 5 6 7 >
How	a nuclear reactor produces electricity	< 1 2 3 4 5 6 7 >
How	a speedometer works	< 1 2 3 4 5 6 7 >
How	the heart pumps blood	< 1 2 3 4 5 6 7 >
How	a water faucet controls water flow	< 1 2 3 4 5 6 7 >
How	a quartz watch keeps time	< 1 2 3 4 5 6 7 >
How	a VCR works	< 1 2 3 4 5 6 7 >
How	a car's gearbox works	< 1 2 3 4 5 6 7 >
How	a cylinder lock opens with a key	< 1 2 3 4 5 6 7 >
How	a helicopter flies	< 1 2 3 4 5 6 7 >
How	a radio receiver works	< 1 2 3 4 5 6 7 >
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How	a computer mouse controls the pointer on a computer screen	< 1 2 3 4 5 6 7 >

How	a scanner captures images	< 1 2 3 4 5 6 7 >
How	a flush toilet operates	< 1 2 3 4 5 6 7 >
How	a hydroelectric turbine changes water pressure into electricity	< 1 2 3 4 5 6 7 >
How	a car battery stores electricity	< 1 2 3 4 5 6 7 >
How	a jet engine produces thrust	< 1 2 3 4 5 6 7 >
How	a self-winding watch runs without batteries	< 1 2 3 4 5 6 7 >
How	a microchip processes information	< 1 2 3 4 5 6 7 >
How	the US Supreme Court determines the constitutionality of laws	< 1 2 3 4 5 6 7 >
How	a photocopier makes copies	< 1 2 3 4 5 6 7 >
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How	the liver removes toxins from blood	< 1 2 3 4 5 6 7 >
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How	the presidential elections determine the next president	< 1 2 3 4 5 6 7 >
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How	an Ethernet network allows computers to share files	< 1 2 3 4 5 6 7 >
How	a transistor works	< 1 2 3 4 5 6 7 >
How	the brain coordinates behavior	< 1 2 3 4 5 6 7 >

Write Explanations

Now, we'd like to probe your knowledge in a little more detail, on some of the items. For each of the following, please describe all the details you know about the phenomena, going from the first step to the last, and providing the causal connection between the steps. That is, your explanation should state precisely how each step causes the next step in one continuous chain from start to finish. In other words, for each phenomenon, try to tell as complete a story as you can, with no gaps.

If you find that your story does have gaps (that is, you are not sure how the steps are connected) please write the word "GAP" in your description at that point, and then continue. Feel free to use labeled diagrams, or flow-charts to get your meaning across.

When you are done, please re-rate your knowledge of the phenomenon on a 1-7 scale.

Explain how a cylinder lock operates, from the point that a key is about to be inserted to when the door opens.

Now, please rate how well you feel you understand this phenomenon.

How a cylinder lock opens with a key	< 1 2 3 4 5 6 7 >
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Explain how a helicopter flies, from the point of rest, through lift-off, to forward flight.

Now, please rate how well you feel you understand this phenomenon.

How a helicopter flies	< 1 2 3 4 5 6 7 >
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Explain how a quartz watch keeps time, from the point when the second hand moves to the point when it moves again.

Now, please rate how well you feel you understand this phenomenon.

How a quartz watch keeps time	< 1 2 3 4 5 6 7 >
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Explain how a sewing machine works, from the moment the needle goes in to make the first stitch to the moment when the needle goes in to make the second stitch.

Now, please rate how well you feel you understand this phenomenon.

How a sewing machine works	< 1 2 3 4 5 6 7 >
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Now please rate how well you feel you understand four additional phenomena:

How a speedometer works	< 1 2 3 4 5 6 7 >
How a zipper works	< 1 2 3 4 5 6 7 >
How piano keys make sounds	< 1 2 3 4 5 6 7 >
How a flush toilet operates	< 1 2 3 4 5 6 7 >

Answer Specific Questions

In this section, we will probe your knowledge a little further, by asking you to describe specific aspects of the mechanisms that make each item work. Please try to answer each of the questions below in as much detail as you can.

How can you pick a cylinder lock (if you don't have a key)?

Now, please rate how well you feel you understand this phenomenon.

How a cylinder lock opens with a key	< 1 2 3 4 5 6 7 >
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Describe, step by step, how the hovering helicopter tilts forward for forward flight.

Now, please rate how well you feel you understand this phenomenon.

How a helicopter flies	< 1 2 3 4 5 6 7 >
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Why doesn't the quartz watch run more slowly as the battery runs lower on power?

Now, please rate how well you feel you understand this phenomenon.

How a quartz watch keeps time	< 1 2 3 4 5 6 7 >
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How does the needle of a sewing machine make stitches that hold two pieces of fabric together, even though it always enters and leaves the fabric from the same direction?

Now, please rate how well you feel you understand this phenomenon.

How a sewing machine works	< 1 2 3 4 5 6 7 >
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Now please rate how well you feel you understand four additional phenomena:

How a speedometer works	< 1 2 3 4 5 6 7 >
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Read Expert Explanations

Below you will find the explanations of each phenomenon provided by an expert. Let's assume that the expert explanations and the diagrams represent Level 7 knowledge. Please read each explanation carefully, and re-rate your initial level of understanding of each explained item (that is, your level of understanding before you read the explanation), and also your current level of understanding of the explained item (that is, how well you feel you understand the phenomenon after you've read the explanation).

Cylinder Lock

Please read the explanation in folder 1.

How well do you feel you understood the phenomenon before reading the explanation?

How a cylinder lock opens with a key	< 1 2 3 4 5 6 7 >
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How well do you feel you understand the phenomenon after reading the explanation?

How a cylinder lock opens with a key	< 1 2 3 4 5 6 7 >
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Helicopter

Please read the explanation in folder 2.

How well do you feel you understood the phenomenon before reading the explanation?

How a helicopter flies	< 1 2 3 4 5 6 7 >
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How well do you feel you understand the phenomenon after reading the explanation?

How a helicopter flies	< 1 2 3 4 5 6 7 >
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Quartz watch

Please read the explanation in folder 3.

How well do you feel you understood the phenomenon before reading the explanation?

How a quartz watch keeps time	< 1 2 3 4 5 6 7 >
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How well do you feel you understand the phenomenon after reading the explanation?

How a quartz watch keeps time	< 1 2 3 4 5 6 7 >
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Sewing machine

Please read the explanation in folder 4.

How well do you feel you understood the phenomenon before reading the explanation?

How a sewing machine works	< 1 2 3 4 5 6 7 >
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How well do you feel you understand the phenomenon after reading the explanation?

How a sewing machine works	< 1 2 3 4 5 6 7 >
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Now please rate how well you feel you understand four additional phenomena:

How a speedometer works	< 1 2 3 4 5 6 7 >
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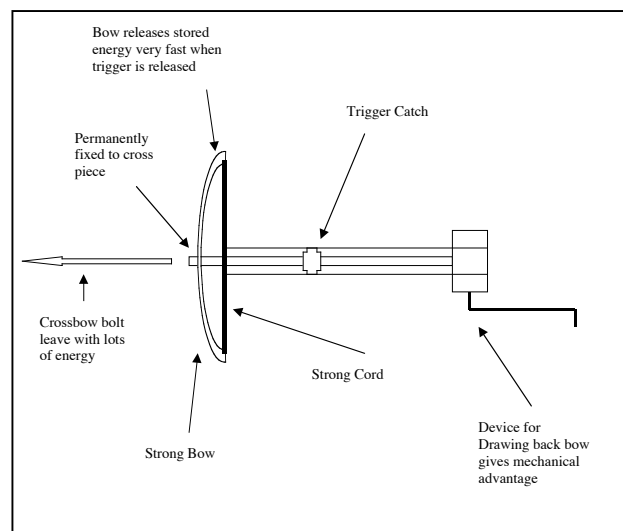
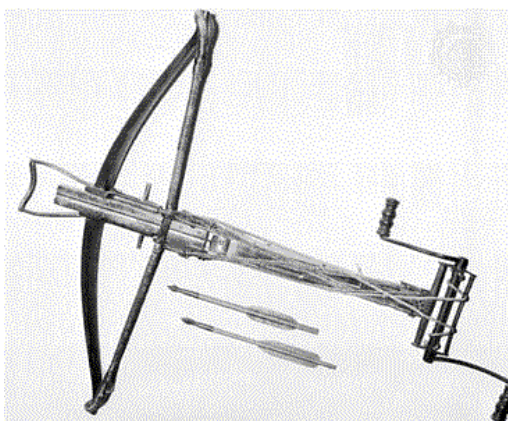
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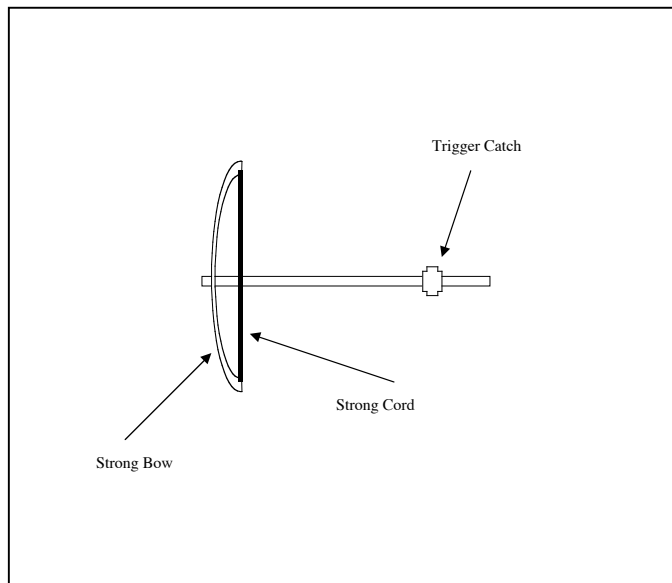
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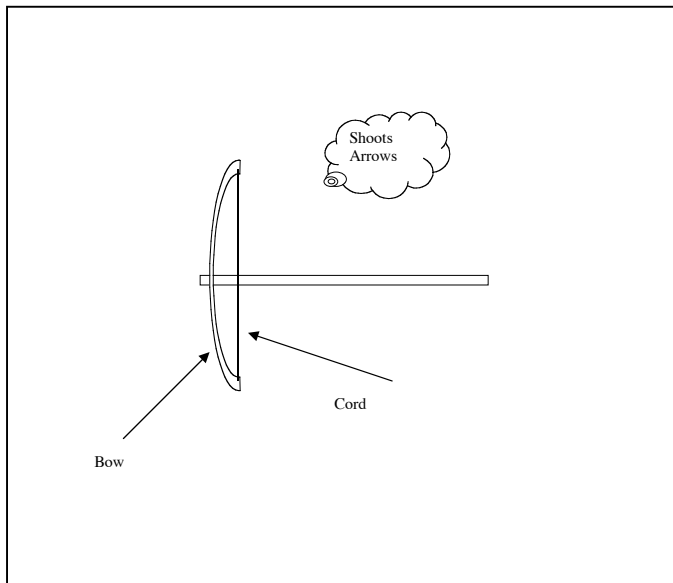
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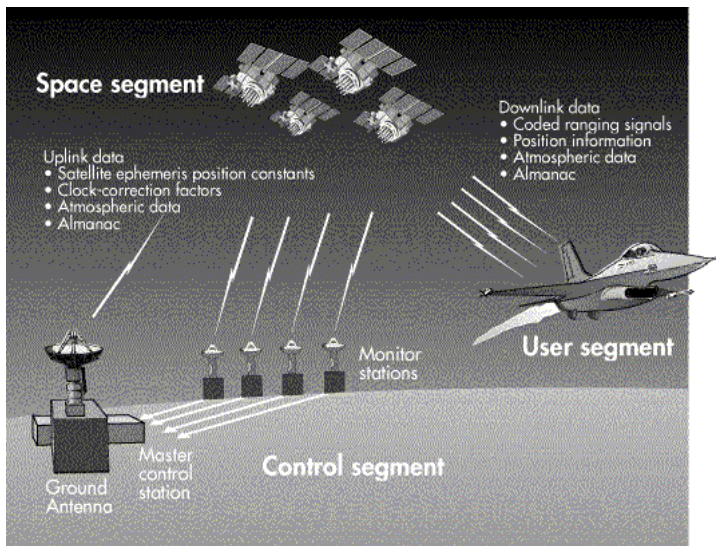
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Write Explanations

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If you find that your story does have gaps (that is, you are not sure how the steps are connected) please write the word "GAP" in your description at that point, and then continue. Feel free to use labeled diagrams, or flow-charts to get your meaning across.

When you are done, please re-rate your knowledge of the phenomenon on a 1-7 scale.

Explain how a speedometer keeps track of speed and distance traveled; start from the movement of the car's drive axle, and end with the movement of the odometer digits and the final position of the speed indicator needle.

Now, please rate how well you feel you understand this phenomenon.

How a speedometer works	< 1 2 3 4 5 6 7 >
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Explain how a zipper closes and opens, starting with the open position, and ending with the open position.

Now, please rate how well you feel you understand this phenomenon.

How a zipper works	< 1 2 3 4 5 6 7 >
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Explain how a piano key transmits the force of the pianist’s finger into sound, from the time the key is pressed to the time it is released.

Now, please rate how well you feel you understand this phenomenon.

How piano keys make sounds	< 1 2 3 4 5 6 7 >
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Explain how a flush toilet operates, from the point that the lever is pulled, to the point when water refills the tank.

Now, please rate how well you feel you understand this phenomenon.

How a flush toilet operates	< 1 2 3 4 5 6 7 >
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Now please rate how well you feel you understand four additional phenomena:

How a cylinder lock opens with a key	< 1 2 3 4 5 6 7 >
How a helicopter flies	< 1 2 3 4 5 6 7 >
How a quartz watch keeps time	< 1 2 3 4 5 6 7 >
How a sewing machine works	< 1 2 3 4 5 6 7 >

Answer Specific Questions

In this section, we will probe your knowledge a little further, by asking you to describe specific aspects of the mechanisms that make each item work. Please try to answer each of the questions below in as much detail as you can.

Describe, step by step, what causes the needle of a speedometer to move from zero to the driving speed, and why that mechanism never wears out from friction.

Now, please rate how well you feel you understand this phenomenon.

How a speedometer works	< 1 2 3 4 5 6 7 >
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Describe, step by step, how the slide traveling down a closed zipper causes it to open.

Now, please rate how well you feel you understand this phenomenon.

How a zipper works	< 1 2 3 4 5 6 7 >
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Why does holding down a piano key allow the sound to sustain, but releasing the key causes sound to stop, unless the dampner pedal is pressed?

Now, please rate how well you feel you understand this phenomenon.

How piano keys make sounds	< 1 2 3 4 5 6 7 >
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Describe, step by step, how the water in a flush toilet bowl goes back to the original level after all the water in the tank is gone.

Now, please rate how well you feel you understand this phenomenon.

How a flush toilet operates	< 1 2 3 4 5 6 7 >
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Now please rate how well you feel you understand four additional phenomena:

How a cylinder lock opens with a key	< 1 2 3 4 5 6 7 >
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How a sewing machine works	< 1 2 3 4 5 6 7 >

Read Expert Explanations

Below you will find the explanations of each phenomenon provided by an expert. Let's assume that the expert explanations and the diagrams represent Level 7 knowledge. Please read each explanation carefully, and re-rate your initial level of understanding of each explained item (that is, your level of understanding before you read the explanation), and also your current level of understanding of the explained item (that is, how well you feel you understand the phenomenon after you've read the explanation).

Speedometer

Please read the explanation in folder 1.

How well do you feel you understood the phenomenon before reading the explanation?

How a speedometer works	< 1 2 3 4 5 6 7 >
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How well do you feel you understand the phenomenon after reading the explanation?

How a speedometer works	< 1 2 3 4 5 6 7 >
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Zipper

Please read the explanation in folder 2.

How well do you feel you understood the phenomenon before reading the explanation?

How a zipper works	< 1 2 3 4 5 6 7 >
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How well do you feel you understand the phenomenon after reading the explanation?

How a zipper works	< 1 2 3 4 5 6 7 >
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Piano Action

Please read the explanation in folder 3.

How well do you feel you understood the phenomenon before reading the explanation?

How piano keys make sounds	< 1 2 3 4 5 6 7 >
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How well do you feel you understand the phenomenon after reading the explanation?

How piano keys make sounds	< 1 2 3 4 5 6 7 >
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Flush Toilet

Please read the explanation in folder 4.

How well do you feel you understood the phenomenon before reading the explanation?

How a flush toilet operates	< 1 2 3 4 5 6 7 >
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How well do you feel you understand the phenomenon after reading the explanation?

How a flush toilet operates	< 1 2 3 4 5 6 7 >
--------------------------------	-------------------

Now please rate how well you feel you understand four additional phenomena:

How a cylinder lock opens with a key	< 1 2 3 4 5 6 7 >
How a helicopter flies	< 1 2 3 4 5 6 7 >
How a quartz watch keeps time	< 1 2 3 4 5 6 7 >

How	a sewing machine works	< 1 2 3 4 5 6 7 >
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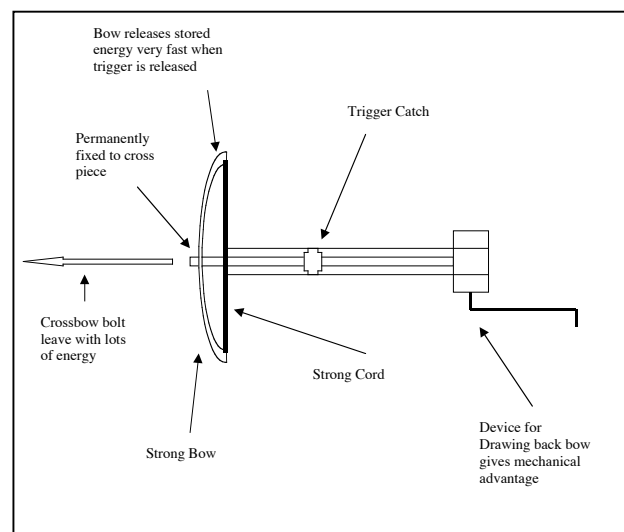
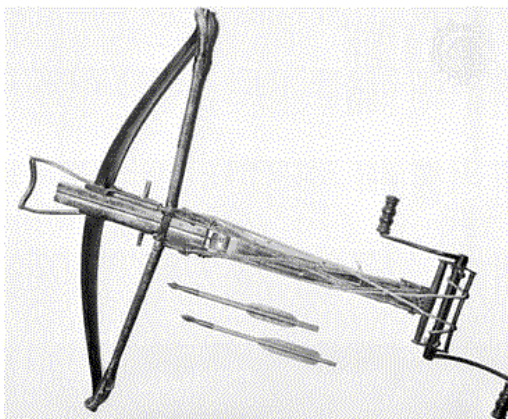
* Stimuli used in Study 4, item-set A. 4 out of the 32 Study 4 participants received this version of the stimuli, and another four received the same item set with the order of the items reversed.

Subject Number	Gender	Major

Introduction

In this experiment you will rate how well you feel you understand how different things work. We'll ask you to rate your understanding on a seven-point scale. Before you get started, this introduction will try to explain what the scores on the scale are supposed to reflect.

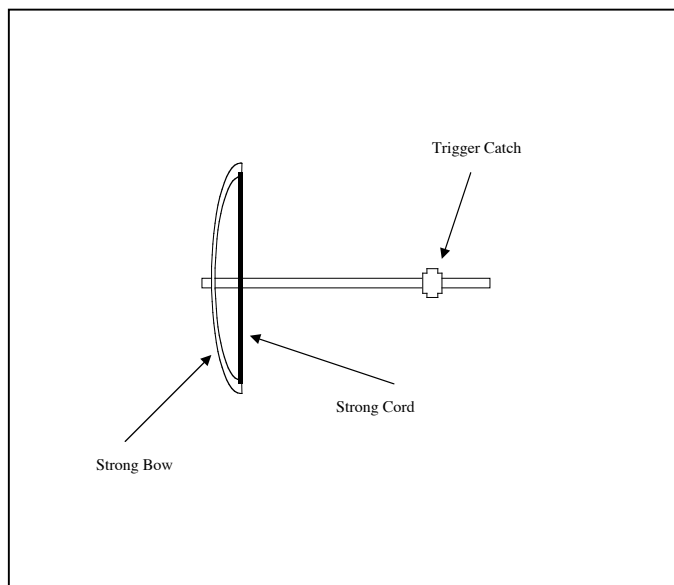
Some things are well-understood: almost everyone knows how and why they work. That is they can tell you about all the parts and how they work together. One such example might be the crossbow. Most people know how it works, e.g., that it has a stiff, flexible piece of metal as a bow with a wire or strong line; that the bow is permanently mounted on a block of wood or metal; that the wire is pulled back by something that gives a mechanical advantage, either a lever, or small block and tackle, or by a crank wound around a spool that pulls a wire attached to the bow wire. The bow wire is then held back by a pin that is connected to a trigger, and an arrow is set in front of it. Often the pin is forked so the arrow can sit directly in the wire. The pin is directly connected to the trigger so that when you pull on the trigger, it causes it to pivot around a point such that the end that is the pin moves downwards and releases the bow wire. When the pin releases the string, the bow very quickly un-flexes, rapidly imparting all the energy stored in the flexed bow to



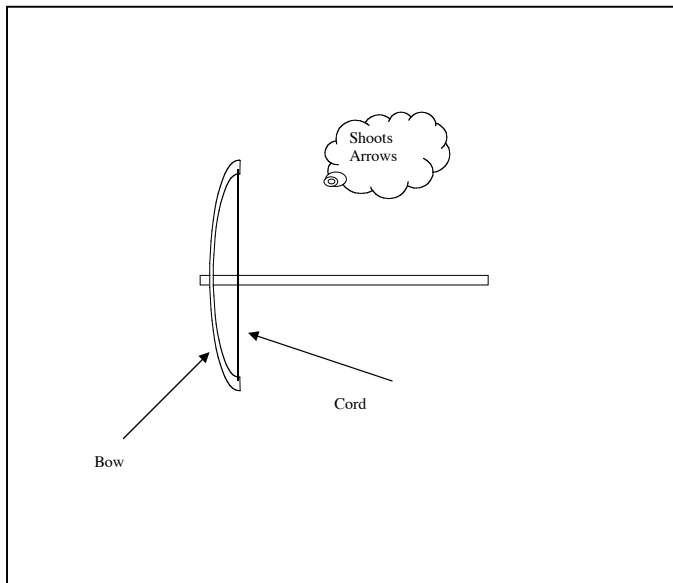
the arrow. (see the picture and diagram below).

So most people have a pretty good idea about how a crossbow works. A person who could draw the diagram above probably has a good understanding of crossbows.

Some people know less detail. For example, someone might know only that the crossbow is a fixed bow and arrow arrangement; that it gets more power than a normal bow and arrow because it allows you to pull the string back extra hard and then trap it there rather than hold it, and that it is then released by a trigger. If this person were to draw a diagram of a crossbow it might look like this.



Some people might know even less. For example, someone might really only know what a crossbow looks like and what it does -- shoots arrows. That person's understanding might be best represented by the following diagram, where the lack of important parts and labels indicate they really don't have any idea about the details.



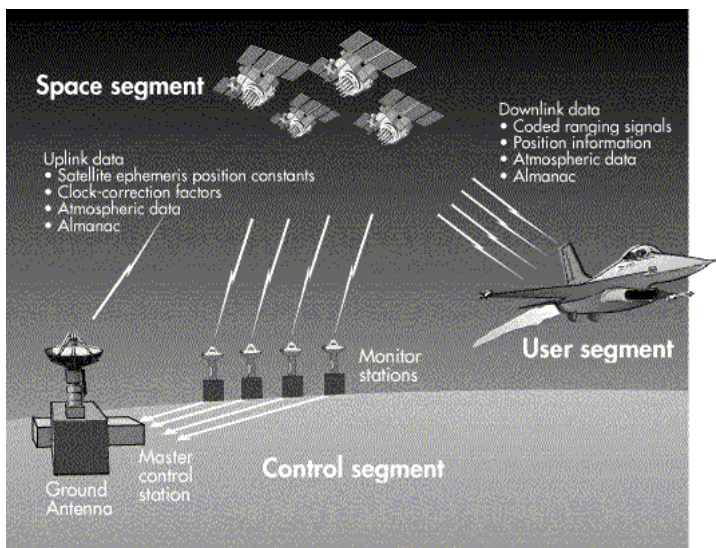
What we tried to demonstrate with the crossbow example is that you can think of knowledge about how things work as arranged along a continuum, which we can represent as a seven-point scale.

<1 2 3 4 5 6 7>

For the crossbow, many people are probably close to a 7, such as the hypothetical person who would draw the first crossbow diagram. Others are close to a 4, such as the hypothetical person who would draw the second crossbow diagram, and some, such as a person who would draw the third crossbow diagram, are close to a 1.

On the other hand, for something like a handheld GPS receiver, most people are probably closer to a 1, knowing only that this thing about the size of a TV remote control tells you where you are anywhere in the world with a high degree of precision. A person with level 3 knowledge might know that GPS handheld receivers get signals from satellites and that, depending on where the receiver is located on the earth, the signals from the satellites create different patterns, and some kind of computational stuff in the handheld receiver computes your position from that combined pattern. A person with level 7 knowledge of GPS receivers would know all about what those signals were, how they varied across different locations, and precisely what calculations the handheld receiver did.

Level 7 knowledge would involve knowing, for example, that the signal measures distance between the receiver and the satellite (by transmitting the exact time at which the signal was sent), and that a receiver measures signals from 4 satellites to compute position. A person with level-7 knowledge would also know why the satellites need ultra-accurate clocks; why knowing the speed of light is important to being able to determine position, why you need a signal from at least three satellites to determine your position exactly, and why the radio signals must be high-frequency. Level-7 knowledge might also involve knowing something about how the entire GPS system operates, e.g., that there are many GPS satellites, monitored by multiple ground stations, and controlled by a master control station (see diagram below).



Note that one does not need to be an expert to have level 7 knowledge – an intelligent, educated lay-person who has read and understood a good description of the phenomenon in an appropriate reference source probably has level 7 knowledge, as we define it. An expert in a particular phenomenon would almost necessarily have level 7 knowledge, since experts know more than even the most knowledgeable lay-people. Thus, our rating scale is not sensitive to degrees of

expert knowledge – the experts know so much they are “off the scale.” The 1-7 scale we described only measures levels of non-expert knowledge.

Instructions

We are trying to get a sense of how people feel about their understandings of various devices and natural phenomena as part of a larger study of how people make sense of the world. We are going to present you with 33 items; we want you to rate on a 7-point scale how well you feel you understand each one. The 7-point scale is based on the description above. That is, you should give the item close to a “7” if you feel your understanding of the item is like most people’s understanding of a crossbow, and close to a “1” if you feel your understanding is like most people’s understanding of a GPS handheld receiver.

There is one tricky part to keep in mind. Some of our participants get confused and think they are rating how well they feel they understand each phenomenon relative to how well other people understand that same phenomenon. **That’s not your task.** We only talked about what other people know about crossbows and GPS receivers to explain what the extremes of the scale mean. The 7 point scale is meant to be absolute – it does not depend on what you think others may know about each item. In other words, you will be rating how well you feel you understand each phenomena relative to all the other phenomena you know (like crossbows, GPS receivers, etc.). Remember, 7 means you have a very thorough understanding of a phenomenon, 1 means you have a very vague understanding of the phenomenon.

Finally, it’s very important to give us your **first impression.** We find that taking too long really hurts people’s answers. Please go through the list below as quickly as possible and circle the number from 1-7 on the scale next to each phenomenon, telling us how well you feel you understand each item.

Phenomena		Scale
How	an LCD screen works	< 1 2 3 4 5 6 7 >
How	a cellular phone works	< 1 2 3 4 5 6 7 >
How	a greenhouse works	< 1 2 3 4 5 6 7 >
How	a fluorescent light works	< 1 2 3 4 5 6 7 >
How	a water faucet controls water flow	< 1 2 3 4 5 6 7 >
How	a VCR works	< 1 2 3 4 5 6 7 >
How	a radio receiver works	< 1 2 3 4 5 6 7 >
How	a telephone transmits sound through wires	< 1 2 3 4 5 6 7 >
How	a fireplace works	< 1 2 3 4 5 6 7 >
How	a solid-fuel rocket produces thrust	< 1 2 3 4 5 6 7 >
How	The aqualung (Scuba-gear) regulates air-pressure	< 1 2 3 4 5 6 7 >
How	a computer mouse controls the pointer on a computer screen	< 1 2 3 4 5 6 7 >
How	a scanner captures images	< 1 2 3 4 5 6 7 >
How	a spray-bottle sprays liquids	< 1 2 3 4 5 6 7 >
How	a manual clutch works	< 1 2 3 4 5 6 7 >
How	an Ethernet network allows computers to share files	< 1 2 3 4 5 6 7 >
How	a transistor works	< 1 2 3 4 5 6 7 >
How	a snare catches small animals	< 1 2 3 4 5 6 7 >
How	an incinerator works	< 1 2 3 4 5 6 7 >
How	a television creates pictures	< 1 2 3 4 5 6 7 >
How	a ball-point pen writes	< 1 2 3 4 5 6 7 >
How	a hydroelectric turbine changes water pressure into electricity	< 1 2 3 4 5 6 7 >
How	a car battery stores electricity	< 1 2 3 4 5 6 7 >

How	a jet engine produces thrust	< 1 2 3 4 5 6 7 >
How	a self-winding watch runs without batteries	< 1 2 3 4 5 6 7 >
How	a microchip processes information	< 1 2 3 4 5 6 7 >
How	a photocopier makes copies	< 1 2 3 4 5 6 7 >
How	a car ignition system starts the engine	< 1 2 3 4 5 6 7 >
How	a car differential helps the car turn	< 1 2 3 4 5 6 7 >
How	an electric motor changes electricity into movement	< 1 2 3 4 5 6 7 >
How	a can opener works	< 1 2 3 4 5 6 7 >
How	a 35MM (single-lens reflex) camera works	< 1 2 3 4 5 6 7 >

Write Explanations

Now, we'd like to probe your knowledge in a little more detail, on some of the items. For each of the following, please describe all the details you know about the phenomena, going from the first step to the last, and providing the causal connection between the steps. That is, your explanation should state precisely how each step causes the next step in one continuous chain from start to finish. In other words, for each phenomenon, try to tell as complete a story as you can, with no gaps.

If you find that your story does have gaps (that is, you are not sure how the steps are connected) please write the word "GAP" in your description at that point, and then continue. Feel free to use labeled diagrams, or flow-charts to get your meaning across.

When you are done, please re-rate your knowledge of the phenomenon on a 1-7 scale.

Explain how a greenhouse works.

Now, please rate how well you feel you understand this phenomenon.

How a greenhouse works	< 1 2 3 4 5 6 7 >
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Explain how a fluorescent light works.

Now, please rate how well you feel you understand this phenomenon.

How a fluorescent light works	< 1 2 3 4 5 6 7 >
-------------------------------	-------------------

Explain how a radio receiver works.

Now, please rate how well you feel you understand this phenomenon.

How a radio receiver works	< 1 2 3 4 5 6 7 >
-------------------------------	-------------------

Explain how a scanner captures images.

Now, please rate how well you feel you understand this phenomenon.

How a scanner captures images	< 1 2 3 4 5 6 7 >
-------------------------------	-------------------

Explain how a manual clutch works.

Now, please rate how well you feel you understand this phenomenon.

How a manual clutch works	< 1 2 3 4 5 6 7 >
---------------------------	-------------------

Explain how a snare catches small animals.

Now, please rate how well you feel you understand this phenomenon.

How a snare catches small animals	< 1 2 3 4 5 6 7 >
--------------------------------------	-------------------

Explain how a television creates pictures.

Now, please rate how well you feel you understand this phenomenon.

How a television creates pictures	< 1 2 3 4 5 6 7 >
---------------------------------------	-------------------

Explain how a can opener works.

Now, please rate how well you feel you understand this phenomenon.

How a can opener works	< 1 2 3 4 5 6 7 >
------------------------	-------------------

Now please rate how well you feel you understand eight additional phenomena:

How an LCD screen works	< 1 2 3 4 5 6 7 >
How a VCR works	< 1 2 3 4 5 6 7 >
How a telephone transmits sound through wires	< 1 2 3 4 5 6 7 >
How the aqualung (Scuba-gear) regulates air pressure	< 1 2 3 4 5 6 7 >
How an Ethernet network allows computers to share files	< 1 2 3 4 5 6 7 >
How a car battery stores electricity	< 1 2 3 4 5 6 7 >
How a photocopier makes copies	< 1 2 3 4 5 6 7 >
How a 35MM (single-lens reflex) camera works	< 1 2 3 4 5 6 7 >

Answer Specific Questions

In this section, we will probe your knowledge a little further, by asking you to describe specific aspects of the mechanisms that make each item work. Please try to answer each of the questions below in as much detail as you can.

Why would you keep gallons upon gallons of water in the green house (more than the plants would need)?

Now, please rate how well you feel you understand this phenomenon.

How a greenhouse works	< 1 2 3 4 5 6 7 >
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Why does the white glow come evenly from the fluorescent bulb, and not just from the electrodes?

Now, please rate how well you feel you understand this phenomenon.

How a fluorescent light works	< 1 2 3 4 5 6 7 >
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Describe step by step how a radio wave received by a radio's antenna gets translated into a sound signal.

Now, please rate how well you feel you understand this phenomenon.

How a radio receiver works	< 1 2 3 4 5 6 7 >
----------------------------	-------------------

Describe step by step how an image becomes electrical signals.

Now, please rate how well you feel you understand this phenomenon.

How a scanner captures images	< 1 2 3 4 5 6 7 >
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Explain step by step what happens when you step on the clutch.

Now, please rate how well you feel you understand this phenomenon.

How a manual clutch works	< 1 2 3 4 5 6 7 >
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Why can't an animal simply back up and loosen the snare?

Now, please rate how well you feel you understand this phenomenon.

How a snare catches small animals	< 1 2 3 4 5 6 7 >
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Why does the image seem to contract to a single point when the television set is turned off?

Now, please rate how well you feel you understand this phenomenon.

How a television creates pictures

< 1 2 3 4 5 6 7 >

Why doesn't the can fall from the can opener when you are done opening it?

Now, please rate how well you feel you understand this phenomenon.

How a can opener works	< 1 2 3 4 5 6 7 >
---------------------------	-------------------

Now please rate how well you feel you understand eight additional phenomena:

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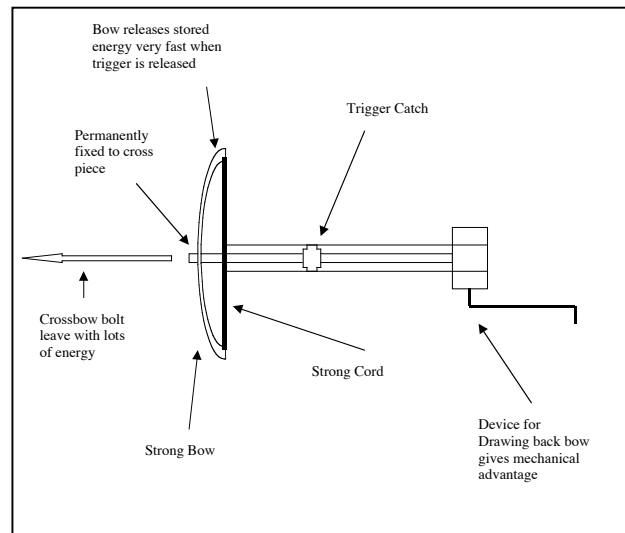
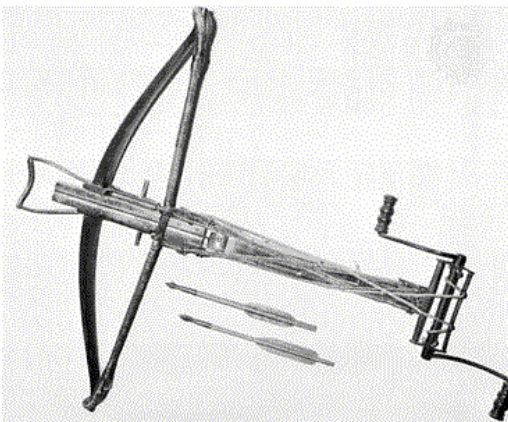
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Introduction

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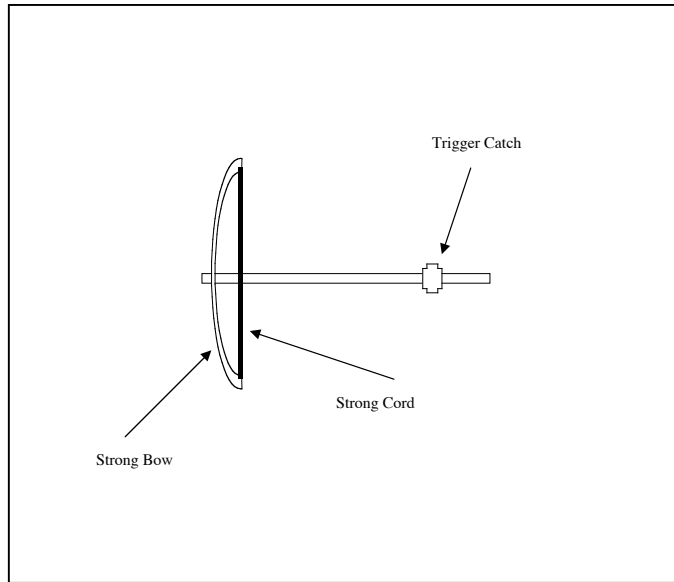
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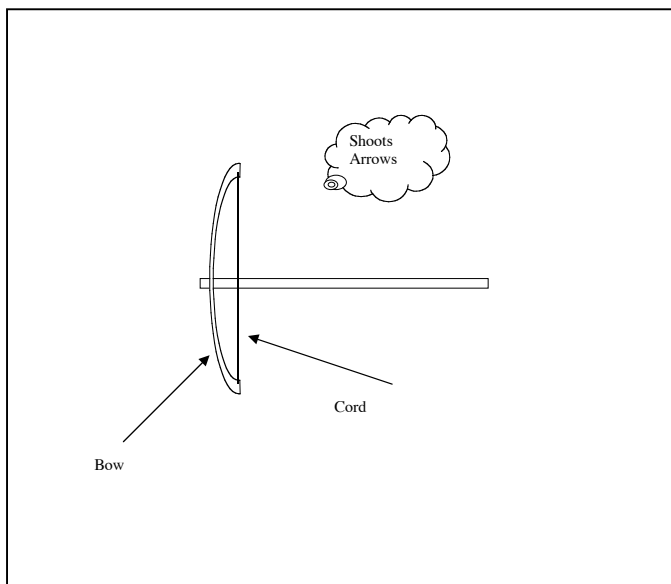
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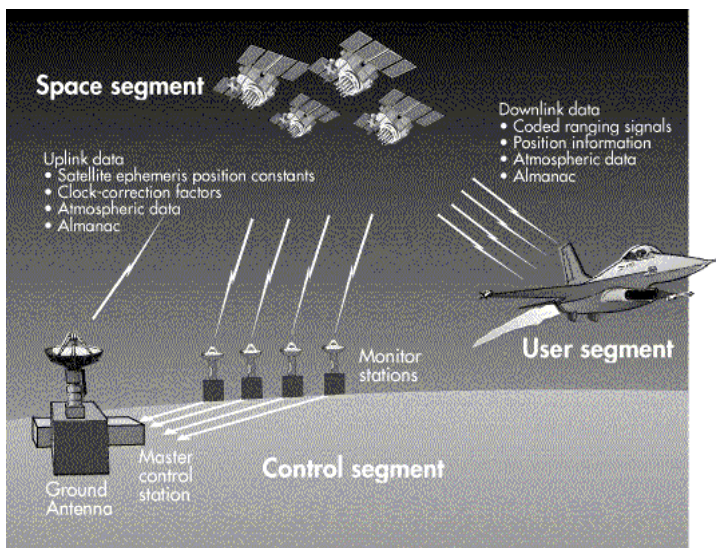
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How	a radio receiver works	< 1 2 3 4 5 6 7 >
How	a telephone transmits sound through wires	< 1 2 3 4 5 6 7 >
How	a fireplace works	< 1 2 3 4 5 6 7 >
How	a solid-fuel rocket produces thrust	< 1 2 3 4 5 6 7 >
How	The aqualung (Scuba-gear) regulates air-pressure	< 1 2 3 4 5 6 7 >
How	a computer mouse controls the pointer on a computer screen	< 1 2 3 4 5 6 7 >
How	a scanner captures images	< 1 2 3 4 5 6 7 >
How	a spray-bottle sprays liquids	< 1 2 3 4 5 6 7 >
How	a manual clutch works	< 1 2 3 4 5 6 7 >
How	an Ethernet network allows computers to share files	< 1 2 3 4 5 6 7 >
How	a transistor works	< 1 2 3 4 5 6 7 >
How	a snare catches small animals	< 1 2 3 4 5 6 7 >
How	an incinerator works	< 1 2 3 4 5 6 7 >
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How	a ball-point pen writes	< 1 2 3 4 5 6 7 >
How	a hydroelectric turbine changes water pressure into electricity	< 1 2 3 4 5 6 7 >
How	a car battery stores electricity	< 1 2 3 4 5 6 7 >

How	a jet engine produces thrust	< 1 2 3 4 5 6 7 >
How	a self-winding watch runs without batteries	< 1 2 3 4 5 6 7 >
How	a microchip processes information	< 1 2 3 4 5 6 7 >
How	a photocopier makes copies	< 1 2 3 4 5 6 7 >
How	a car ignition system starts the engine	< 1 2 3 4 5 6 7 >
How	a car differential helps the car turn	< 1 2 3 4 5 6 7 >
How	an electric motor changes electricity into movement	< 1 2 3 4 5 6 7 >
How	a can opener works	< 1 2 3 4 5 6 7 >
How	a 35MM (single-lens reflex) camera works	< 1 2 3 4 5 6 7 >

Write Explanations

Now, we'd like to probe your knowledge in a little more detail, on some of the items. For each of the following, please describe all the details you know about the phenomena, going from the first step to the last, and providing the causal connection between the steps. That is, your explanation should state precisely how each step causes the next step in one continuous chain from start to finish. In other words, for each phenomenon, try to tell as complete a story as you can, with no gaps.

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When you are done, please re-rate your knowledge of the phenomenon on a 1-7 scale.

Explain how an LCD screen works.

Now, please rate how well you feel you understand this phenomenon.

How An LCD screen works	< 1 2 3 4 5 6 7 >
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Explain how a VCR works.

Now, please rate how well you feel you understand this phenomenon.

How a VCR works	< 1 2 3 4 5 6 7 >
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Explain how a telephone transmits sound through wires.

Now, please rate how well you feel you understand this phenomenon.

How a telephone transmits sound through wires	< 1 2 3 4 5 6 7 >
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Explain how the aqualung (Scuba-gear) regulates air pressure.

Now, please rate how well you feel you understand this phenomenon.

How The aqualung (Scuba-gear) regulates air-pressure	< 1 2 3 4 5 6 7 >
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Explain how an Ethernet network allows computers to share files.

Now, please rate how well you feel you understand this phenomenon.

How an Ethernet network allows computers to share files	< 1 2 3 4 5 6 7 >
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Explain how a car battery stores electricity

Now, please rate how well you feel you understand this phenomenon.

How a car battery stores electricity	< 1 2 3 4 5 6 7 >
--------------------------------------	-------------------

Explain how a photocopier makes copies.

Now, please rate how well you feel you understand this phenomenon.

How a photocopier makes copies	< 1 2 3 4 5 6 7 >
--------------------------------	-------------------

Explain how a 35MM (single-lens reflex) camera works.

Now, please rate how well you feel you understand this phenomenon.

How a 35MM (single-lens reflex) camera works	< 1 2 3 4 5 6 7 >
--	-------------------

Now please rate how well you feel you understand eight additional phenomena:

How a greenhouse works	< 1 2 3 4 5 6 7 >
How a fluorescent light works	< 1 2 3 4 5 6 7 >
How a radio receiver works	< 1 2 3 4 5 6 7 >
How a scanner captures images	< 1 2 3 4 5 6 7 >
How a manual clutch works	< 1 2 3 4 5 6 7 >
How a snare captures small animals	< 1 2 3 4 5 6 7 >
How a television creates pictures	< 1 2 3 4 5 6 7 >
How a can opener works	< 1 2 3 4 5 6 7 >

Answer Specific Questions

In this section, we will probe your knowledge a little further, by asking you to describe specific aspects of the mechanisms that make each item work. Please try to answer each of the questions below in as much detail as you can.

Why do LCD screens use so little power compared to a regular screen?

Now, please rate how well you feel you understand this phenomenon.

How An LCD screen works	< 1 2 3 4 5 6 7 >
----------------------------	-------------------

How are sound signal tracks recorded on videotape?

Now, please rate how well you feel you understand this phenomenon.

How a VCR works	< 1 2 3 4 5 6 7 >
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How does the headset change the speaker's voice into an electrical signal?

Now, please rate how well you feel you understand this phenomenon.

How a telephone transmits sound through wires	< 1 2 3 4 5 6 7 >
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How does the regulator know how much pressure is just right for the scuba diver at every depth?

Now, please rate how well you feel you understand this phenomenon.

How	The aqualung (Scuba-gear) regulates air-pressure	< 1 2 3 4 5 6 7 >
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How does the information sent from your computer over the network know where to go?

Now, please rate how well you feel you understand this phenomenon.

How an Ethernet network allows computers to share files

< 1 2 3 4 5 6 7 >

Why does a car battery lose charge when it's cold?

Now, please rate how well you feel you understand this phenomenon.

How a car battery stores electricity	< 1 2 3 4 5 6 7 >
---	-------------------

Describe step by step how an image gets turned into a pattern of ink on paper by a photocopying machine.

Now, please rate how well you feel you understand this phenomenon.

How a photocopier makes copies	< 1 2 3 4 5 6 7 >
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Describe step by step how light that gets through the lens forms images on the film.

Now, please rate how well you feel you understand this phenomenon.

How a 35MM (single-lens reflex) camera works	< 1 2 3 4 5 6 7 >
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Now please rate how well you feel you understand eight additional phenomena:

How a greenhouse works	< 1 2 3 4 5 6 7 >
How a fluorescent light works	< 1 2 3 4 5 6 7 >
How a radio receiver works	< 1 2 3 4 5 6 7 >
How a scanner captures images	< 1 2 3 4 5 6 7 >
How a manual clutch works	< 1 2 3 4 5 6 7 >
How a snare captures small animals	< 1 2 3 4 5 6 7 >
How a television creates pictures	< 1 2 3 4 5 6 7 >
How a can opener works	< 1 2 3 4 5 6 7 >

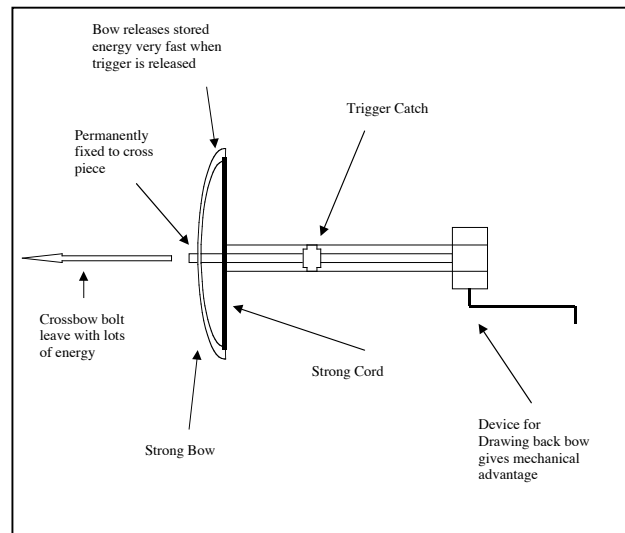
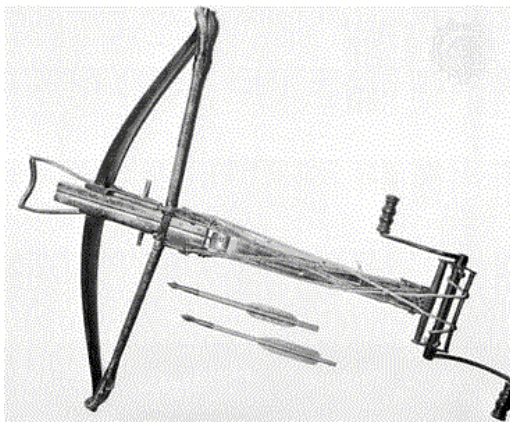
* Stimuli used in Study 4, item-set C. 4 out of the 32 Study 4 participants received this version of the stimuli, and another four received the same item set with the order of the items reversed.

Subject Number	Gender	Major

Introduction

In this experiment you will rate how well you feel you understand how different things work. We'll ask you to rate your understanding on a seven-point scale. Before you get started, this introduction will explain what the scores on the scale are supposed to reflect.

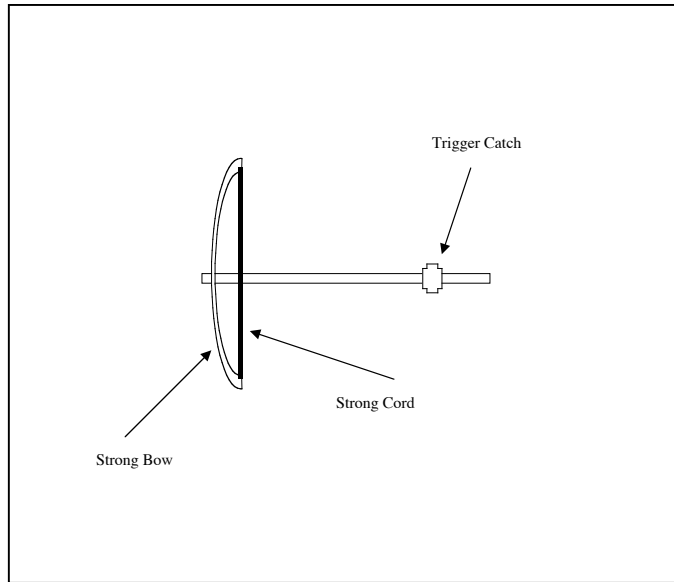
Some things are well-understood: almost everyone knows how and why they work. That is, they can tell you about all the parts and how they work together. One such example might be the crossbow. Most people know how it works, e.g., that it has a stiff, flexible piece of metal as a bow with a wire or strong line; that the bow is permanently mounted on a block of wood or metal; that the wire is pulled back by something that gives a mechanical advantage, either a lever, or small block and tackle, or by a crank wound around a spool that pulls a wire attached to the bow wire. The bow wire is then held back by a pin that is connected to a trigger, and an arrow is set in front of it. Often the pin is forked so the arrow can sit directly in the wire. The pin is directly connected to the trigger so that when you pull on the trigger, it causes it to pivot around a point such that the end that is the pin moves downwards and releases the bow wire. When the pin releases the string, the bow very quickly un-flexes, rapidly imparting all the energy stored in the flexed bow to



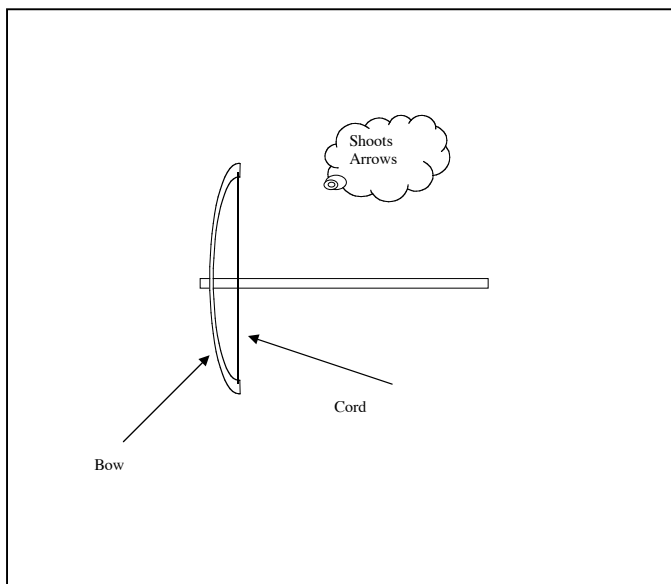
the arrow. (see the picture and diagram below).

So most people have a pretty good idea about how a crossbow works. A person who could draw the diagram above probably has a good understanding of crossbows.

Some people know less detail. For example, someone might know only that the crossbow is a fixed bow and arrow arrangement; that it gets more power than a normal bow and arrow because it allows you to pull the string back extra hard and then trap it there rather than hold it, and that it is then released by a trigger. If this person were to draw a diagram of a crossbow it might look like this.



Some people might know even less. For example, someone might really only know what a crossbow looks like and what it does -- shoots arrows. That person's understanding might be best represented by the following diagram, where the lack of important parts and labels indicate they really don't have any idea about the details.



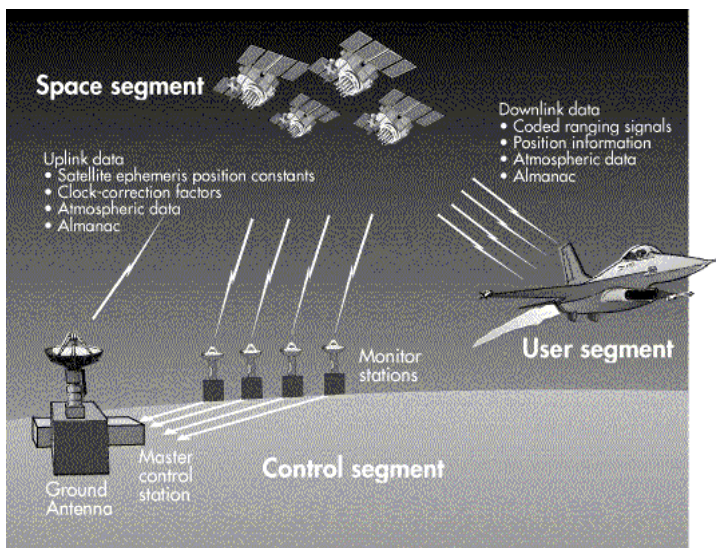
What we tried to demonstrate with the crossbow example is that you can think of knowledge about how things work as arranged along a continuum, which we can represent as a seven-point scale.

<1 2 3 4 5 6 7>

For the crossbow, many people are probably close to a 7, such as the hypothetical person who would draw the first crossbow diagram. Others are close to a 4, such as the hypothetical person who would draw the second crossbow diagram, and some, such as a person who would draw the third crossbow diagram, are close to a 1.

On the other hand, for something like a handheld GPS receiver, most people are probably closer to a 1, knowing only that this thing about the size of a TV remote control tells you where you are anywhere in the world with a high degree of precision. A person with level 3 knowledge might know that GPS handheld receivers get signals from satellites and that, depending on where the receiver is located on the earth, the signals from the satellites create different patterns, and some kind of computational stuff in the handheld receiver computes your position from that combined pattern. A person with level 7 knowledge of GPS receivers would know all about what those signals were, how they varied across different locations, and precisely what calculations the handheld receiver did.

Level 7 knowledge would involve knowing, for example, that the signal measures distance between the receiver and the satellite (by transmitting the exact time at which the signal was sent), and that a receiver measures signals from 4 satellites to compute position. A person with level 7 knowledge would also know why the satellites need ultra-accurate clocks; why knowing the speed of light is important to being able to determine position, why you need a signal from at least three satellites to determine your position exactly, and why the radio signals must be high-frequency. Level 7 knowledge might also involve knowing something about how the entire GPS system operates, e.g., that there are many GPS satellites, monitored by multiple ground stations, and controlled by a master control station (see diagram below).



Note that one does not need to be an expert to have level 7 knowledge – an intelligent, educated lay-person who has read and understood a good description of the phenomenon in an appropriate reference source probably has level 7 knowledge, as we define it. An expert in a particular phenomenon would almost necessarily have level 7 knowledge, since experts know more than even the most knowledgeable lay-people. Thus, our rating scale is not sensitive to degrees of

expert knowledge – the experts know so much they are “off the scale.” The 1-7 scale we described only measures levels of non-expert knowledge.

Instructions

We are trying to get a sense of how people feel about their understandings of various devices and natural phenomena as part of a larger study of how people make sense of the world. We are going to present you with 33 items; we want you to rate on a 7-point scale how well you feel you understand each one. The 7-point scale is based on the description above. That is, you should give the item close to a “7” if you feel your understanding of the item is like most people’s understanding of a crossbow, and close to a “1” if you feel your understanding is like most people’s understanding of a GPS handheld receiver.

There is one tricky part to keep in mind. Some of our participants get confused and think they are rating how well they feel they understand each phenomenon relative to how well other people understand that same phenomenon. **That’s not your task.** We only talked about what other people know about crossbows and GPS receivers to explain what the extremes of the scale mean. The 7 point scale is meant to be absolute – it does not depend on what you think others may know about each item. In other words, you will be rating how well you feel you understand each phenomena relative to all the other phenomena you know (like crossbows, GPS receivers, etc.). Remember, 7 means you have a very thorough understanding of a phenomenon, 1 means you have a very vague understanding of the phenomenon.

Finally, it’s very important to give us your **first impression.** We find that taking too long really hurts people’s answers. Please go through the list below as quickly as possible and circle the number from 1-7 on the scale next to each phenomenon, telling us how well you feel you understand each item.

Rating 1:

Phenomena		Scale
How	an LCD screen works	< 1 2 3 4 5 6 7 >
How	a cellular phone works	< 1 2 3 4 5 6 7 >
How	a greenhouse works	< 1 2 3 4 5 6 7 >
How	a fluorescent light works	< 1 2 3 4 5 6 7 >
How	a water faucet controls water flow	< 1 2 3 4 5 6 7 >
How	a VCR works	< 1 2 3 4 5 6 7 >
How	a radio receiver works	< 1 2 3 4 5 6 7 >
How	a telephone transmits sound through wires	< 1 2 3 4 5 6 7 >
How	a fireplace works	< 1 2 3 4 5 6 7 >
How	a solid-fuel rocket produces thrust	< 1 2 3 4 5 6 7 >
How	The aqualung (Scuba-gear) regulates air-pressure	< 1 2 3 4 5 6 7 >
How	a computer mouse controls the pointer on a computer screen	< 1 2 3 4 5 6 7 >
How	a scanner captures images	< 1 2 3 4 5 6 7 >
How	a spray-bottle sprays liquids	< 1 2 3 4 5 6 7 >
How	a manual clutch works	< 1 2 3 4 5 6 7 >
How	an Ethernet network allows computers to share files	< 1 2 3 4 5 6 7 >
How	a transistor works	< 1 2 3 4 5 6 7 >
How	a snare catches small animals	< 1 2 3 4 5 6 7 >
How	an incinerator works	< 1 2 3 4 5 6 7 >
How	a television creates pictures	< 1 2 3 4 5 6 7 >
How	a ball-point pen writes	< 1 2 3 4 5 6 7 >
How	a hydroelectric turbine changes water pressure into electricity	< 1 2 3 4 5 6 7 >
How	a car battery stores electricity	< 1 2 3 4 5 6 7 >

How	a jet engine produces thrust	< 1 2 3 4 5 6 7 >
How	a self-winding watch runs without batteries	< 1 2 3 4 5 6 7 >
How	a microchip processes information	< 1 2 3 4 5 6 7 >
How	a photocopier makes copies	< 1 2 3 4 5 6 7 >
How	a car ignition system starts the engine	< 1 2 3 4 5 6 7 >
How	a car differential helps the car turn	< 1 2 3 4 5 6 7 >
How	an electric motor changes electricity into movement	< 1 2 3 4 5 6 7 >
How	a can opener works	< 1 2 3 4 5 6 7 >
How	a 35MM (single-lens reflex) camera works	< 1 2 3 4 5 6 7 >

Write Explanations

Now, we'd like to probe your knowledge in a little more detail, on some of the items. For each of the following, please describe all the details you know about the phenomena, going from the first step to the last, and providing the causal connection between the steps. That is, your explanation should state precisely how each step causes the next step in one continuous chain from start to finish. In other words, for each phenomenon, try to tell as complete a story as you can, with no gaps.

If you find that your story does have gaps (that is, you are not sure how the steps are connected) please write the word "GAP" in your description at that point, and then continue. Feel free to use labeled diagrams, or flow-charts to get your meaning across.

When you are done, please re-rate your knowledge of the phenomenon on a 1-7 scale.

Explain how a cellular phone works.

Now, please rate how well you feel you understand this phenomenon.

How a cellular phone works	< 1 2 3 4 5 6 7 >
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Explain how a water faucet controls water flow.

Now, please rate how well you feel you understand this phenomenon.

How a water faucet controls water flow	< 1 2 3 4 5 6 7 >
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Explain how a fireplace works.

Now, please rate how well you feel you understand this phenomenon.

How a fireplace works	< 1 2 3 4 5 6 7 >
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Explain how a solid-fuel rocket produces thrust.

Now, please rate how well you feel you understand this phenomenon.

How a solid-fuel rocket produces thrust	< 1 2 3 4 5 6 7 >
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Explain how a computer mouse controls the pointer on a computer screen.

Now, please rate how well you feel you understand this phenomenon.

How a computer mouse controls the pointer on a computer screen	< 1 2 3 4 5 6 7 >
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Explain how a transistor works.

Now, please rate how well you feel you understand this phenomenon.

How a transistor works	< 1 2 3 4 5 6 7 >
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Explain how a self-winding watch runs without batteries.

Now, please rate how well you feel you understand this phenomenon.

How a self-winding watch runs without batteries	< 1 2 3 4 5 6 7 >
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Explain how a car ignition system starts the engine.

Now, please rate how well you feel you understand this phenomenon.

How a car ignition system starts the engine	< 1 2 3 4 5 6 7 >
---	-------------------

Now please rate how well you feel you understand eight additional phenomena:

How	a spray-bottle sprays liquids	< 1 2 3 4 5 6 7 >
How	an incinerator works	< 1 2 3 4 5 6 7 >
How	a ball-point pen writes	< 1 2 3 4 5 6 7 >
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Answer Specific Questions

In this section, we will probe your knowledge a little further, by asking you to describe specific aspects of the mechanisms that make each item work. Please try to answer each of the questions below in as much detail as you can.

How can thousands of people use cellular phones in the same city without interfering with each other's conversations?

Now, please rate how well you feel you understand this phenomenon.

How a cellular phone works	< 1 2 3 4 5 6 7 >
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Why doesn't water pressure build up when the faucet handle is turned off?

Now, please rate how well you feel you understand this phenomenon.

How well a water faucet controls water flow	< 1 2 3 4 5 6 7 >
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What factors must you take into effect if your fireplace starts smoking when the flu is open?

Now, please rate how well you feel you understand this phenomenon.

How a fireplace works	< 1 2 3 4 5 6 7 >
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What determines how fast a rocket can go?

Now, please rate how well you feel you understand this phenomenon.

How a solid-fuel rocket produces thrust	< 1 2 3 4 5 6 7 >
--	-------------------

Describe step by step how the rolling ball of a mouse transmits movement information to the computer as an electrical signal.

Now, please rate how well you feel you understand this phenomenon.

How a computer mouse controls the pointer on a computer screen	< 1 2 3 4 5 6 7 >
--	-------------------

Explain how changes in voltage on different parts of the silicon turn the transistor on and off.

Now, please rate how well you feel you understand this phenomenon.

How a transistor works	< 1 2 3 4 5 6 7 >
------------------------	-------------------

What stops the mainspring of a self-winding watch from being over-wound?

Now, please rate how well you feel you understand this phenomenon.

How a self-winding watch runs without batteries	< 1 2 3 4 5 6 7 >
--	-------------------

How would you hotwire a car?

Now, please rate how well you feel you understand this phenomenon.

How a car ignition system starts the engine	< 1 2 3 4 5 6 7 >
---	-------------------

Now please rate, one final time, how well you feel you understand these eight phenomena:

How	a spray-bottle sprays liquids	< 1 2 3 4 5 6 7 >
How	an incinerator works	< 1 2 3 4 5 6 7 >
How	a ball-point pen writes	< 1 2 3 4 5 6 7 >
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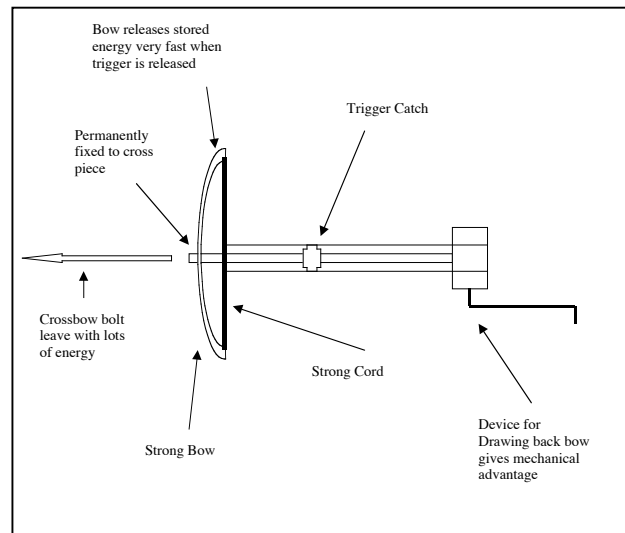
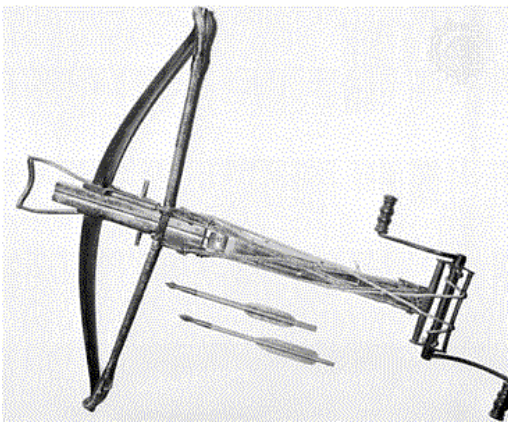
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Introduction

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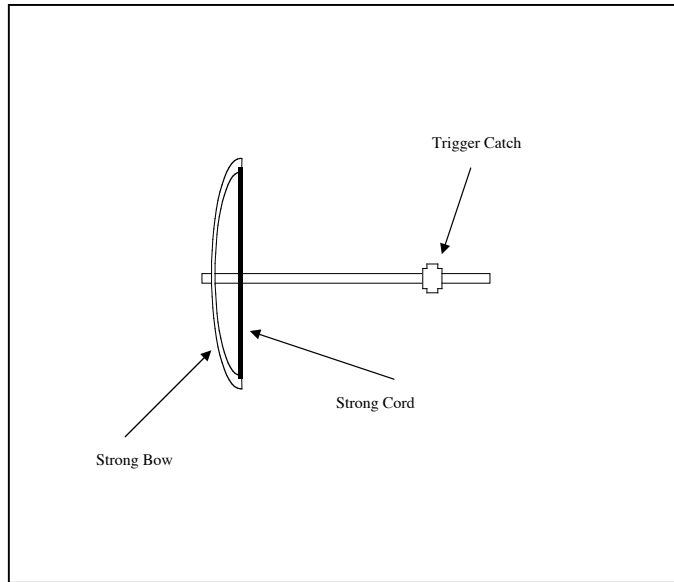
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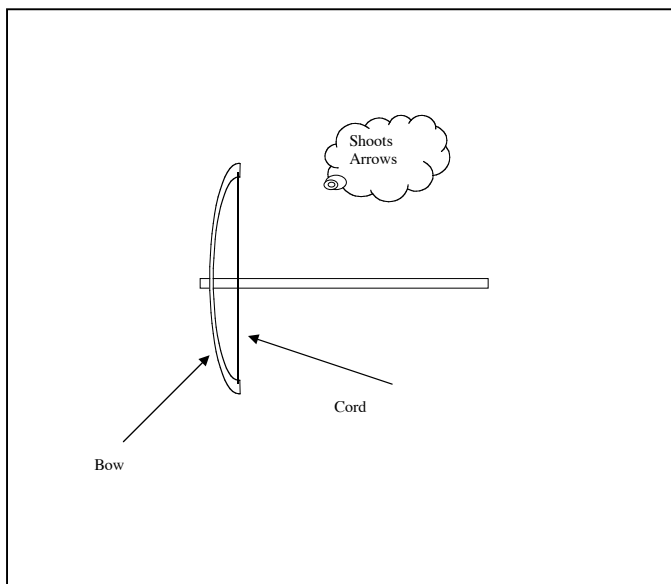
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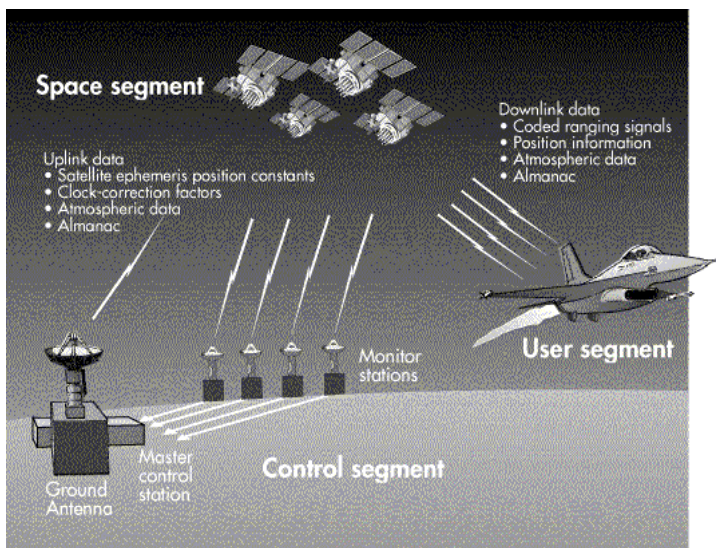
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Rating 1: Distracters & Test (Randomized)

Phenomena		Scale
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How	a cellular phone works	< 1 2 3 4 5 6 7 >
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How	a VCR works	< 1 2 3 4 5 6 7 >
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How	The aqualung (Scuba-gear) regulates air-pressure	< 1 2 3 4 5 6 7 >
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How	a television creates pictures	< 1 2 3 4 5 6 7 >
How	a ball-point pen writes	< 1 2 3 4 5 6 7 >
How	a hydroelectric turbine changes water pressure into electricity	< 1 2 3 4 5 6 7 >
How	a car battery stores electricity	< 1 2 3 4 5 6 7 >

How	a jet engine produces thrust	< 1 2 3 4 5 6 7 >
How	a self-winding watch runs without batteries	< 1 2 3 4 5 6 7 >
How	a microchip processes information	< 1 2 3 4 5 6 7 >
How	a photocopier makes copies	< 1 2 3 4 5 6 7 >
How	a car ignition system starts the engine	< 1 2 3 4 5 6 7 >
How	a car differential helps the car turn	< 1 2 3 4 5 6 7 >
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Write Explanations

Now, we'd like to probe your knowledge in a little more detail, on some of the items. For each of the following, please describe all the details you know about the phenomena, going from the first step to the last, and providing the causal connection between the steps. That is, your explanation should state precisely how each step causes the next step in one continuous chain from start to finish. In other words, for each phenomenon, try to tell as complete a story as you can, with no gaps.

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When you are done, please re-rate your knowledge of the phenomenon on a 1-7 scale.

Explain how an electric motor changes electricity into movement.

Now, please rate how well you feel you understand this phenomenon.

How an electric motor changes electricity into movement	< 1 2 3 4 5 6 7 >
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Explain how a car differential helps the car turn.

Now, please rate how well you feel you understand this phenomenon.

How a car differential helps the car turn	< 1 2 3 4 5 6 7 >
---	-------------------

Explain how a microchip processes information.

Now, please rate how well you feel you understand this phenomenon.

How a microchip processes information	< 1 2 3 4 5 6 7 >
---------------------------------------	-------------------

Explain how a jet engine produces thrust.

Now, please rate how well you feel you understand this phenomenon.

How a jet engine produces thrust	< 1 2 3 4 5 6 7 >
----------------------------------	-------------------

Explain how a hydroelectric turbine changes water pressure into electricity.

Now, please rate how well you feel you understand this phenomenon.

How a hydroelectric turbine changes water pressure into electricity	< 1 2 3 4 5 6 7 >
---	-------------------

Explain how a ball-point pen writes.

Now, please rate how well you feel you understand this phenomenon.

How a ball-point pen writes	< 1 2 3 4 5 6 7 >
-----------------------------	-------------------

Explain how an incinerator works.

Now, please rate how well you feel you understand this phenomenon.

How an incinerator works	< 1 2 3 4 5 6 7 >
--------------------------	-------------------

Explain how a spray-bottle sprays liquids.

Now, please rate how well you feel you understand this phenomenon.

How a spray-bottle sprays liquids	< 1 2 3 4 5 6 7 >
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Now please rate how well you feel you understand eight additional phenomena:

How	a cellular phone works	< 1 2 3 4 5 6 7 >
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Answer Specific Questions

In this section, we will probe your knowledge a little further, by asking you to describe specific aspects of the mechanisms that make each item work. Please try to answer each of the questions below in as much detail as you can.

Explain what would happen if you plugged an A/C motor into a D/C circuit.

Now, please rate how well you feel you understand this phenomenon.

How an electric motor changes electricity into movement	< 1 2 3 4 5 6 7 >
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How do car wheels know that they should turn at different speeds when the car makes a turn?

Now, please rate how well you feel you understand this phenomenon.

How a car differential helps the car turn	< 1 2 3 4 5 6 7 >
---	-------------------

What happens during each "Hertz" cycle (as in 300 Mega Hertz) to the voltage within the microchip?

Now, please rate how well you feel you understand this phenomenon.

How a microchip processes information	< 1 2 3 4 5 6 7 >
---------------------------------------	-------------------

Why does air need to be compressed before it reaches the combustion chamber of a jet engine?

Now, please rate how well you feel you understand this phenomenon.

How a jet engine produces thrust	< 1 2 3 4 5 6 7 >
----------------------------------	-------------------

Why is it easier to make bigger turbines efficient than smaller ones?

Now, please rate how well you feel you understand this phenomenon.

How a hydroelectric turbine changes water pressure into electricity	< 1 2 3 4 5 6 7 >
---	-------------------

How does the solid-looking ink in a ballpoint pen cartridge keep moving toward the tip of the pen?

Now, please rate how well you feel you understand this phenomenon.

How a ball-point pen writes	< 1 2 3 4 5 6 7 >
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Exactly what is left over when things have been incinerated and why?

Now, please rate how well you feel you understand this phenomenon.

How an incinerator works	< 1 2 3 4 5 6 7 >
--------------------------	-------------------

How does pulling the trigger of a spray-bottle both pull up liquid from the bottle and spray it out of the nozzle?

Now, please rate how well you feel you understand this phenomenon.

How a spray-bottle sprays liquids	< 1 2 3 4 5 6 7 >
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Now please rate, one final time, how well you feel you understand these eight phenomena:

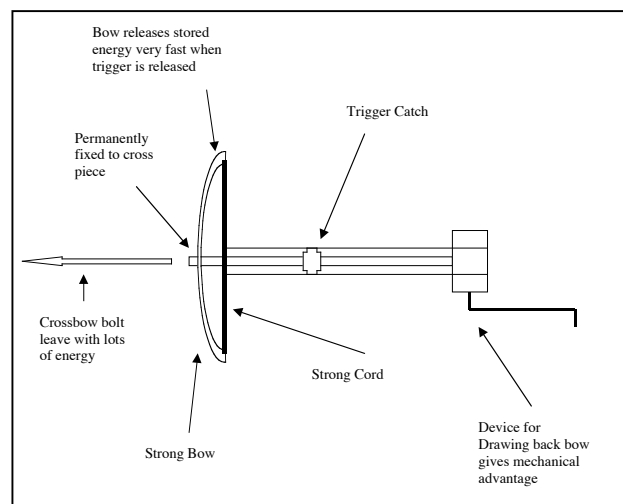
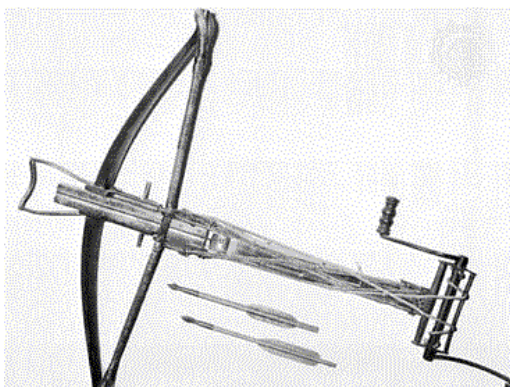
How	a cellular phone works	< 1 2 3 4 5 6 7 >
How	a water faucet controls water flow	< 1 2 3 4 5 6 7 >
How	a fireplace works	< 1 2 3 4 5 6 7 >
How	a solid-fuel rocket produces thrust	< 1 2 3 4 5 6 7 >
How	a computer mouse controls the pointer on a computer screen	< 1 2 3 4 5 6 7 >
How	a transistor works	< 1 2 3 4 5 6 7 >
How	a self-winding watch runs without batteries	< 1 2 3 4 5 6 7 >
How	a car ignition system starts the engine	< 1 2 3 4 5 6 7 >

* Instructions used in Study 5.

Introduction

In this task you will rate explanations of how different things work. We'll ask you to rate each explanation on a seven-point scale. Before you get started, this introduction will try to explain what the scores on the scale are supposed to reflect.

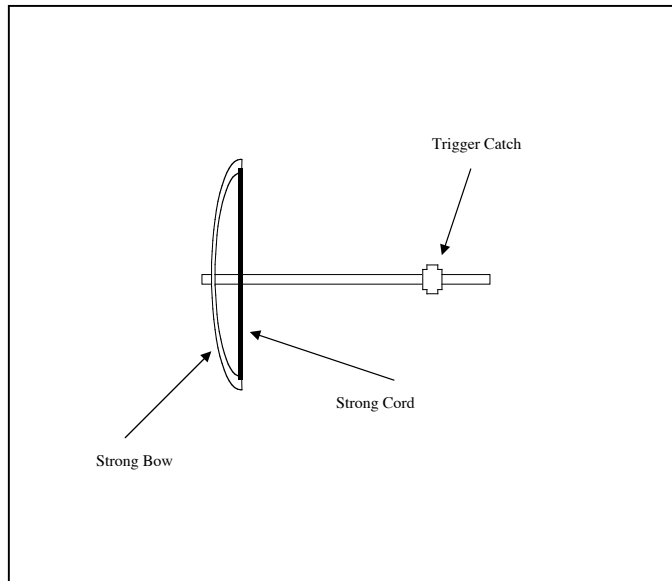
Some things are well-understood: almost everyone knows how and why they work. That is, they can tell you about all the parts and how they work together. One such example might be the crossbow. Most people know how it works, e.g., that it has a stiff, flexible piece of metal as a bow with a wire or strong line; that the bow is permanently mounted on a block of wood or metal; that the wire is pulled back by something that gives a mechanical advantage, either a lever, or small block and tackle, or by a crank wound around a spool that pulls a wire attached to the bow



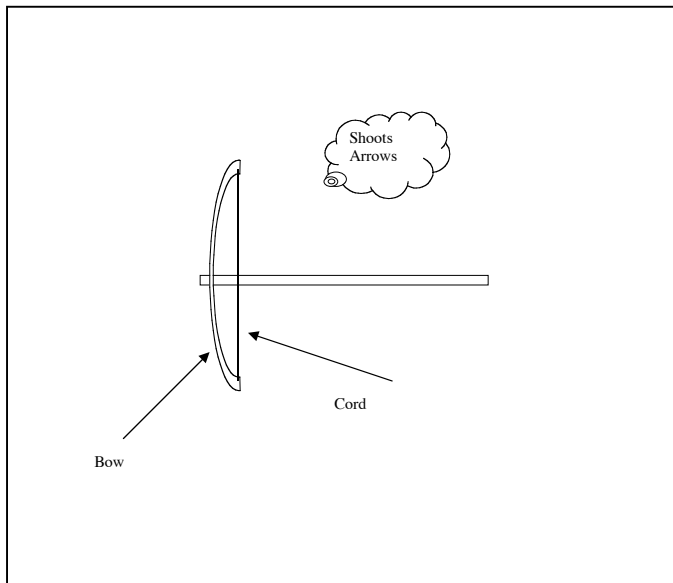
wire. The bow wire is then held back by a pin that is connected to a trigger, and an arrow is set in front of it. Often the pin is forked so the arrow can sit directly on the wire. The pin is directly connected to the trigger so that when you pull on the trigger, it causes it to pivot around a point such that the end that is the pin moves downwards and releases the bow wire. When the pin releases the string, the bow very quickly un-flexes, rapidly imparting all the energy stored in the flexed bow to the arrow. (see the picture and diagram below).

So most people have a pretty good idea about how a crossbow works. A person who could draw the diagram above probably has a good understanding of crossbows.

Some people know less detail. For example, someone might know only that the crossbow is a fixed bow and arrow arrangement, that it gets more power than a normal bow and arrow because it allows you to pull the string back extra hard and then trap it there rather than hold it, and that it is then released by a trigger. If this person were to draw a diagram of a crossbow it might look like this.



Some people might know even less. For example, someone might really only know what a crossbow looks like and what it does -- shoots arrows. That person's understanding might be best represented by the following diagram, where the lack of important parts and labels indicate they really don't have any idea about the details.



What we tried to demonstrate with the crossbow example is that you can think of knowledge about how things work as arranged along a continuum, which we can represent as a seven-point scale.

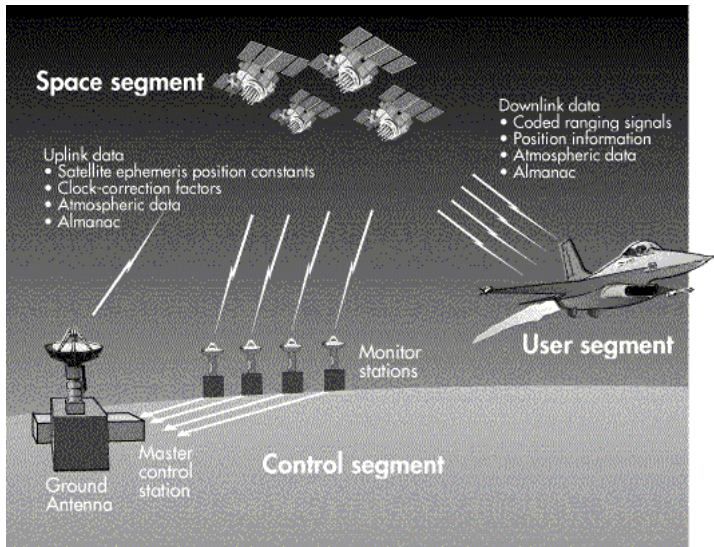
<1 2 3 4 5 6 7>

For the crossbow, many people are probably close to a 7, such as the hypothetical person who would draw the first crossbow diagram. Others are close to a 4, such as the hypothetical person who would draw the second crossbow diagram, and some, such as a person who would draw the third crossbow diagram, are close to a 1.

On the other hand, for something like a handheld GPS receiver, most people are probably closer to a 1, knowing only that this thing about the size of a TV remote control tells you where you are anywhere in the world with a high degree of precision. A person with level 3 knowledge might know that GPS handheld receivers get signals from satellites and that, depending on where the receiver is located on the earth, the signals from the satellites create different patterns, and some kind of computational stuff in the handheld receiver computes your position from that combined pattern. A person with level 7 knowledge of GPS receivers would know all about what those signals were, how they varied across different locations, and precisely what calculations the handheld receiver did.

Level 7 knowledge would involve knowing, for example, that the signal measures distance between the receiver and the satellite (by transmitting the exact time at which the signal was sent), and that a receiver measures signals from 4 satellites to compute position. A person with level 7 knowledge would also know why the satellites need ultra-accurate clocks; why knowing the speed of light is important to being able to determine position, why you need a signal from at least three satellites

to determine your position exactly, and why the radio signals must be high-frequency. Level-7 knowledge might also involve knowing something about how the entire GPS system operates, e.g., that there are many GPS satellites, monitored by multiple ground stations, and controlled by a master control station (see diagram below).



Note that one does not need to be an expert to have level 7 knowledge – an intelligent, educated lay-person who has read and understood a good description of the phenomenon in an appropriate reference source probably has level 7 knowledge, as we define it. An expert in a particular phenomenon would almost necessarily have level 7 knowledge, since experts know more than even the most knowledgeable lay-people. Thus, our rating scale is not sensitive to degrees of expert knowledge – the experts know so much they are “off the scale.” The 1-7 scale we described only measures levels of non-expert knowledge.

Instructions

Part A

We are going to present you with sets of explanations for 8 different items, written by other college students. We want you to rate each explanation on a 7-point scale just described. That is, you should give the explanation close to a "7" if you feel the explanation of the item is very good, and close to a "1" if you feel the explanation is very poor.

A note about the explanations: we asked the explanation writers to insert the word "GAP" in their description to indicate gaps in their knowledge about a given item (that is, points at which they were uncertain how the steps in the sequence from input to output should connect). In some cases, the explanation writers felt like they didn't know anything about an item, and so left the explanation blank.

Please go through explanation sets A1-A8 and rate each explanation writer's knowledge on the 1-7 scale provided below each explanation. We have also provided a "no explanation" check-box that you can mark instead of using the 1-7 scale, if you feel that the scale is inapplicable because no explanation at all has been provided (e.g., the explanation is blank, or only says "GAP").

You will begin on "the launch-pad," which has a button for each explanation set (marked A1-A8 and B1-B8). To begin, click on explanation set A1. You will be brought to the first explanation in the set. After rating this explanation, click "next" to continue to the next explanation in the set, and so on. (If you need to go back to a previous explanation in a set for some reason you can click the "back" button, but you cannot return all the way to the launch-pad by going backwards.) When you have rated the final explanation in the set, clicking "next" will bring you back to the launch-pad, where you should select explanation set A2 to continue.

After you have rated explanation set A8, please stop and read the instructions for the second half of the task.

Part B

In part B, you will be provided with explanations of each phenomenon written by an expert. Let's assume that the expert explanations and the diagrams represent level-7 knowledge. After reading each expert explanation carefully, please go through explanation sets B1-B8 (which are the same explanations you saw in A1-A8), and re-rate each explanation set, this time using the expert explanation as the standard for level-7 knowledge.

Starting on "the launch-pad," click on explanation set B1. You will be brought to an expert explanation of the phenomenon described in set B1. When you have read the expert explanation carefully and feel you understand it thoroughly, click 'continue.' Clicking "continue" will take you to the first explanation in set B1. Proceed as you did in Part A.

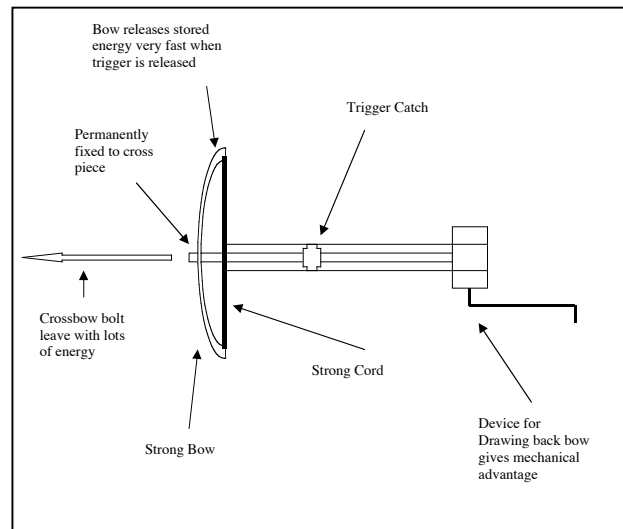
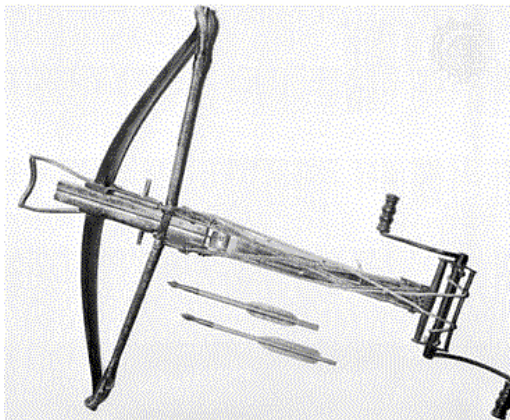
Note: if you need to go back to look at the expert rating for a particular set again, you can do so by clicking the “back” button repeatedly. You can then return to where you left off by clicking “continue” and then clicking the “next” button repeatedly until you get to the first un-rated explanation.

* Instructions used in Study 6. Except for the modified instructions, the stimuli were identical to those used in Studies 1-3.

Introduction

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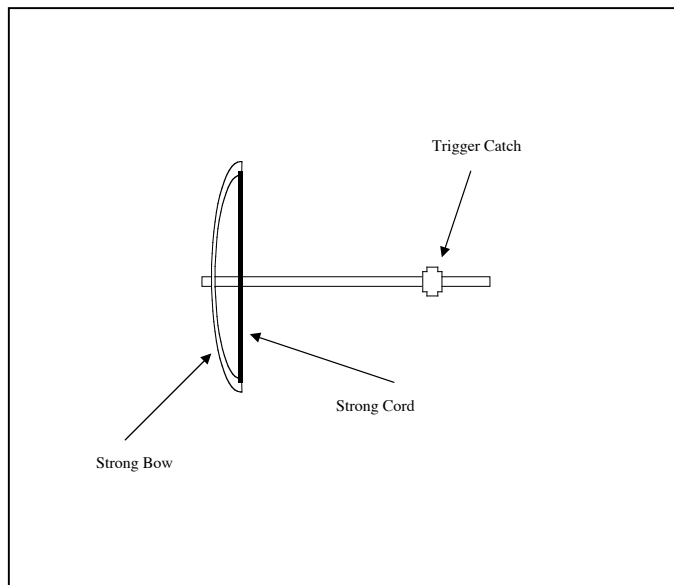
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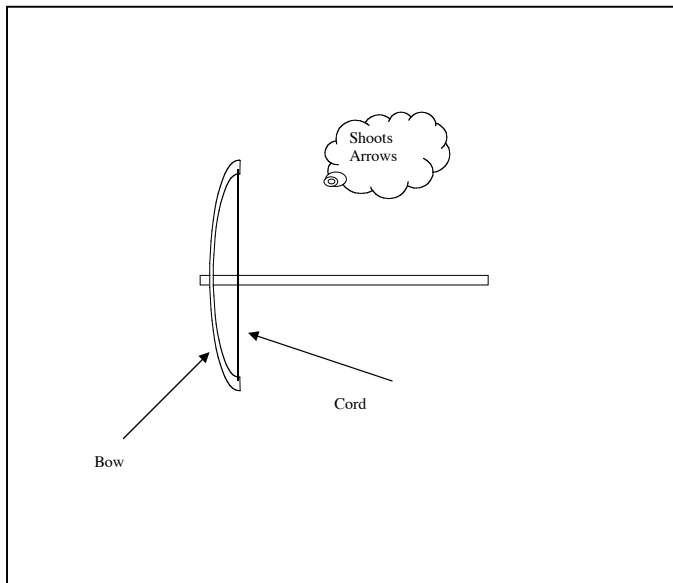
the arrow. (see the picture and diagram below).

So most people have a pretty good idea about how a crossbow works. A person who could draw the diagram above probably has a good understanding of crossbows.

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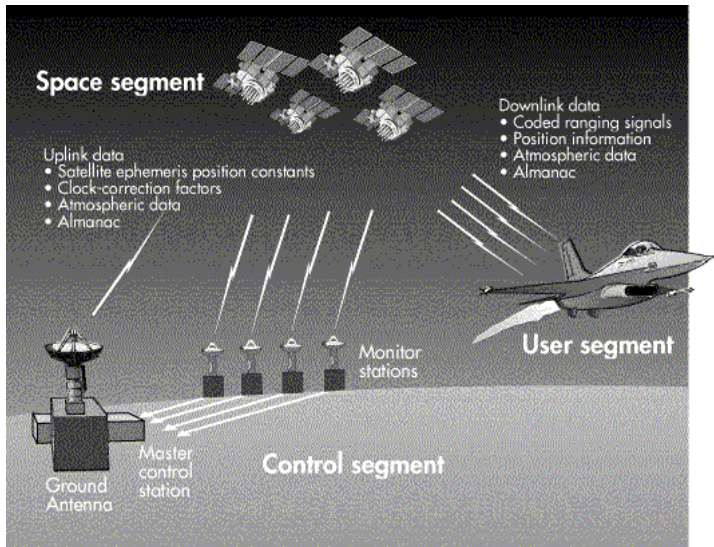
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Instructions

Part A

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After you have rated explanation set A8, please stop and read the instructions for the second half of the task.

Part B

In part B, you will be provided with explanations of each phenomenon written by an expert. Let's assume that the expert explanations and the diagrams represent level-7 knowledge. After reading each expert explanation carefully, please go through explanation sets B1-B8 (which are the same explanations you saw in A1-A8), and re-rate each explanation set, this time using the expert explanation as the standard for level-7 knowledge.

Starting on "the launch-pad," click on explanation set B1. You will be brought to an expert explanation of the phenomenon described in set B1. When you have read the expert explanation carefully and feel you understand it thoroughly, click 'continue.' Clicking "continue" will take you to the first explanation in set B1. Proceed as you did in Part A.

Note: if you need to go back to look at the expert rating for a particular set again, you can do so by clicking the “back” button repeatedly. You can then return to where you left off by clicking “continue” and then clicking the “next” button repeatedly until you get to the first un-rated explanation.

* Stimuli used in Study 7: item-set A.

Subject Number	Gender	Major

Introduction

In this experiment you will rate how well you feel you know the capitals of various countries. We will ask you to rate your knowledge on a seven-point scale. Before you get started, this introduction will try to explain what the scores on the scale are supposed to reflect.

There are some capitals that almost everyone can name. When people name these capitals, they usually feel certain that they are correct. There are other capitals that people are less sure about, and when they try to name these, they feel less certain that they are correct. For example, they may know the names of some major cities in a particular country, but be unsure about the capital city, or they might know two cities that they think could be the capital, but be unsure about which one actually is. Then there are some capitals that people might be even less sure about: they might not have any idea about what the capital is.

As you can see, our knowledge about capitals can be arranged on a continuum, which we can represent as a seven-point scale.

No idea < 1 2 3 4 5 6 7 > Very sure

Instructions

In this experiment, you will rate how well you feel you know the capitals of a list of countries. We’ll ask you to rate your knowledge on a seven-point scale.

We are trying to get a sense of how people feel about their knowledge of capital cities as part of a larger study of how people make sense of the world. We are going to present you with 48 items; we want you to rate on a 7-point scale how well you feel you know each one. The 7-point scale is based on the description above. That is, you should give the item close to a “7” if you feel you are sure you know the capital and a “1” if you have no idea what the capital might be.

There is one tricky part to keep in mind. Some of our participants get confused and think they are rating how well they feel they know each capital relative to how well

other people know the capitals of certain countries. **That's not your task**. We are interested only in how well you feel **YOU** know each capital.

Finally, it's very important to give us your **first impression**. We find that taking too long really hurts people's answers. Please go through the list below as quickly as possible and circle the number from 1-7 on the scale next to each country, telling us how well you feel you know each capital.

No idea < 1 2 3 4 5 6 7 > Very sure

IMPORTANT NOTE: We find that answering the questions out of order also hurts people's answers. Please answer the questions in the order in which they are presented. The questions are usually presented in rows and columns. Please complete *every item* in each **row** (from left to right) before moving on the next row.

COUNTRY	RATING
Burkina Faso	< 1 2 3 4 5 6 7 >
Mauritius	< 1 2 3 4 5 6 7 >
Japan	< 1 2 3 4 5 6 7 >
Norway	< 1 2 3 4 5 6 7 >
Argentina	< 1 2 3 4 5 6 7 >
United Kingdom	< 1 2 3 4 5 6 7 >
New Zealand	< 1 2 3 4 5 6 7 >
Chile	< 1 2 3 4 5 6 7 >
Bosnia	< 1 2 3 4 5 6 7 >
Lesotho	< 1 2 3 4 5 6 7 >
Bolivia	< 1 2 3 4 5 6 7 >
Burundi	< 1 2 3 4 5 6 7 >
Benin	< 1 2 3 4 5 6 7 >
Russia	< 1 2 3 4 5 6 7 >
Togo	< 1 2 3 4 5 6 7 >

Liechtenstein	< 1 2 3 4 5 6 7 >
Brazil	< 1 2 3 4 5 6 7 >
Italy	< 1 2 3 4 5 6 7 >
Spain	< 1 2 3 4 5 6 7 >
Angola	< 1 2 3 4 5 6 7 >
China	< 1 2 3 4 5 6 7 >
Kyrgyzstan	< 1 2 3 4 5 6 7 >
Australia	< 1 2 3 4 5 6 7 >
Iraq	< 1 2 3 4 5 6 7 >
Columbia	< 1 2 3 4 5 6 7 >
Ireland	< 1 2 3 4 5 6 7 >
Saudi Arabia	< 1 2 3 4 5 6 7 >
Cambodia	< 1 2 3 4 5 6 7 >
Bulgaria	< 1 2 3 4 5 6 7 >
Eritrea	< 1 2 3 4 5 6 7 >
Uzbekistan	< 1 2 3 4 5 6 7 >
Nicaragua	< 1 2 3 4 5 6 7 >
Tajikistan	< 1 2 3 4 5 6 7 >
Poland	< 1 2 3 4 5 6 7 >
Iran	< 1 2 3 4 5 6 7 >
Kazakhstan	< 1 2 3 4 5 6 7 >
Egypt	< 1 2 3 4 5 6 7 >
Bhutan	< 1 2 3 4 5 6 7 >
Namibia	< 1 2 3 4 5 6 7 >
Cuba	< 1 2 3 4 5 6 7 >
Canada	< 1 2 3 4 5 6 7 >

United States	< 1 2 3 4 5 6 7 >
Taiwan	< 1 2 3 4 5 6 7 >
Germany	< 1 2 3 4 5 6 7 >
Pakistan	< 1 2 3 4 5 6 7 >
India	< 1 2 3 4 5 6 7 >
France	< 1 2 3 4 5 6 7 >
Morocco	< 1 2 3 4 5 6 7 >
Gabon	< 1 2 3 4 5 6 7 >

Write Capital Names

Now, we'd like to probe your knowledge in a little more detail on some of the items. Please write the capital names for each of the following countries.

If you are unsure about a capital name, please guess. If you do not know the capital, you may leave the space blank.

After you write the name of each capital, please re-rate your knowledge of *that capital* on a 1-7 scale in the adjacent column.

IMPORTANT: Please rate your knowledge immediately after you try to name the capital. DO NOT go on to name the next capital until you have completed the rating column for the previous capital

Write the capital names for each of the following countries, then rate how well you feel you know each one.

COUNTRY	CAPITAL	RATING
Burkina Faso		< 1 2 3 4 5 6 7 >
Japan		< 1 2 3 4 5 6 7 >
Norway		< 1 2 3 4 5 6 7 >
United Kingdom		< 1 2 3 4 5 6 7 >
Chile		< 1 2 3 4 5 6 7 >
Lesotho		< 1 2 3 4 5 6 7 >
Bolivia		< 1 2 3 4 5 6 7 >

Benin		< 1 2 3 4 5 6 7 >
Liechtenstein		< 1 2 3 4 5 6 7 >
Italy		< 1 2 3 4 5 6 7 >
China		< 1 2 3 4 5 6 7 >
Kyrgyzstan		< 1 2 3 4 5 6 7 >
Australia		< 1 2 3 4 5 6 7 >
Ireland		< 1 2 3 4 5 6 7 >
Saudi Arabia		< 1 2 3 4 5 6 7 >
Bulgaria		< 1 2 3 4 5 6 7 >
Uzbekistan		< 1 2 3 4 5 6 7 >
Iran		< 1 2 3 4 5 6 7 >
Kazakhstan		< 1 2 3 4 5 6 7 >
Egypt		< 1 2 3 4 5 6 7 >
Namibia		< 1 2 3 4 5 6 7 >
Canada		< 1 2 3 4 5 6 7 >
Germany		< 1 2 3 4 5 6 7 >
Pakistan		< 1 2 3 4 5 6 7 >

Now, please rate how well you feel you know the capitals for each of the following countries:

COUNTRY	RATING
Mauritius	< 1 2 3 4 5 6 7 >
Argentina	< 1 2 3 4 5 6 7 >
New Zealand	< 1 2 3 4 5 6 7 >
Bosnia	< 1 2 3 4 5 6 7 >

Burundi	< 1 2 3 4 5 6 7 >
Russia	< 1 2 3 4 5 6 7 >
Togo	< 1 2 3 4 5 6 7 >
Brazil	< 1 2 3 4 5 6 7 >
Spain	< 1 2 3 4 5 6 7 >
Angola	< 1 2 3 4 5 6 7 >
Iraq	< 1 2 3 4 5 6 7 >
Columbia	< 1 2 3 4 5 6 7 >
Cambodia	< 1 2 3 4 5 6 7 >
Eritrea	< 1 2 3 4 5 6 7 >
Nicaragua	< 1 2 3 4 5 6 7 >
Tajikistan	< 1 2 3 4 5 6 7 >
Poland	< 1 2 3 4 5 6 7 >
Bhutan	< 1 2 3 4 5 6 7 >
Cuba	< 1 2 3 4 5 6 7 >
United States	< 1 2 3 4 5 6 7 >
Taiwan	< 1 2 3 4 5 6 7 >
France	< 1 2 3 4 5 6 7 >
Morocco	< 1 2 3 4 5 6 7 >
Gabon	< 1 2 3 4 5 6 7 >

Correct Capitals

Finally, take the time to look at each of the following capital city names. After you read the correct capital for each country, re-rate how well you feel you actually knew the name of each capital *before* reading the correct answer.

IMPORTANT: Please rate your knowledge immediately after you read the name of each capital. DO NOT read all the correct answers first and then re-rate your knowledge.

<i>COUNTRY</i>	<i>CAPITAL</i>	RATING
Burkina Faso	Ouagadougou	< 1 2 3 4 5 6 7 >
Japan	Tokyo	< 1 2 3 4 5 6 7 >
Norway	Oslo	< 1 2 3 4 5 6 7 >
United Kingdom	London	< 1 2 3 4 5 6 7 >
Chile	Santiago	< 1 2 3 4 5 6 7 >
Lesotho	Masuru	< 1 2 3 4 5 6 7 >
Bolivia	La Paz	< 1 2 3 4 5 6 7 >
Benin	Porto-Novo	< 1 2 3 4 5 6 7 >
Liechtenstein	Vaduz	< 1 2 3 4 5 6 7 >
Italy	Rome	< 1 2 3 4 5 6 7 >
China	Beijing	< 1 2 3 4 5 6 7 >
Kyrgyzstan	Bishkek	< 1 2 3 4 5 6 7 >
Australia	Canberra	< 1 2 3 4 5 6 7 >
Ireland	Dublin	< 1 2 3 4 5 6 7 >
Saudi Arabia	Riyadh	< 1 2 3 4 5 6 7 >
Bulgaria	Sofia	< 1 2 3 4 5 6 7 >
Uzbekistan	Tashkent	< 1 2 3 4 5 6 7 >
Iran	Tehran	< 1 2 3 4 5 6 7 >
Kazakhstan	Astana	< 1 2 3 4 5 6 7 >
Egypt	Cairo	< 1 2 3 4 5 6 7 >
Namibia	Windhoek	< 1 2 3 4 5 6 7 >
Canada	Ottawa	< 1 2 3 4 5 6 7 >

Germany	Berlin	< 1 2 3 4 5 6 7 >
Pakistan	Islamabad	< 1 2 3 4 5 6 7 >

* Stimuli used in Study 7: item-set B.

* Stimuli used in Study 8:

Subject Number	Gender	Major

Introduction

In this experiment you will rate how well you feel you understand various procedures. We'll ask you to rate your understanding on a seven-point scale. Before you get started, this introduction will try to explain what the scores on the scale are supposed to reflect.

Some people don't have a very good understanding of a particular procedure. For example, if they are asked about the correct procedure for how to fold an American flag, they would not be able to say much. They might know that there are a series of folds that have to be made, but they don't know how to make the particular folds.

Some people may know more details about folding an American flag. They may know that two people need to work together to fold the flag, that initially the flag is folded widthwise, and that ultimately the flag ends up folded into a small triangle with stars showing. Yet, they do not know all of the steps.

Some people understand a particular procedure very well. That is, they can tell you about all the steps involved. For example, when asked about the correct procedure for folding an American flag, they might say:

Step 1: Get ready with your partner

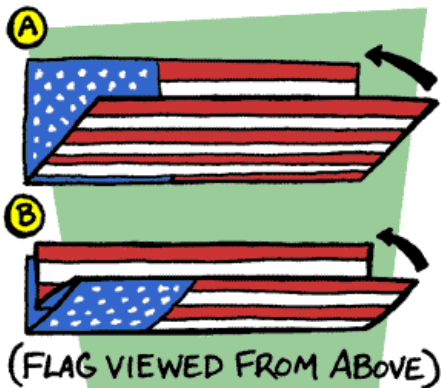


Grab your partner and your flag. Stand facing your partner while you hold two corners of the flag and he or she holds the other two at about waist level. The flag should be parallel to the ground, and the sides facing both of you should be the shorter ones.

Careful--it's taboo to let the flag touch the ground.

Step 2: Fold widthwise twice

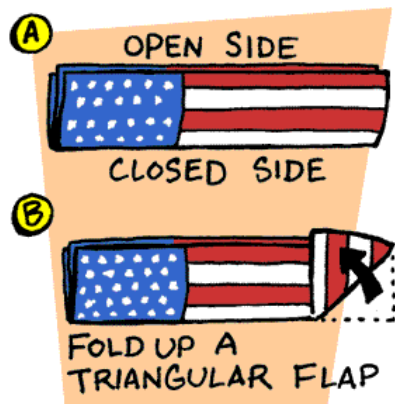
Raise the side of the flag that normally hangs on the bottom, the side entirely covered by stripes, over the side with the "union" on it (the union is the upper corner of the flag with the stars). Grab the new corner you have made along the crease so that again the flag is parallel to the ground, all-stripe side up.



Repeat this widthwise fold so that the union is now on either side, half facing the ground and half facing the sky.

Step 3: Corner your flag

Now that you're holding your twice-folded flag, notice that of the new rectangle shape you have made, one long side is "open," and one is "closed." The open side consists of the original perimeter of the flag--you can still separate the folds into individual layers of material. The crease on the other side encloses the layers of fabric under it, so it's "closed."

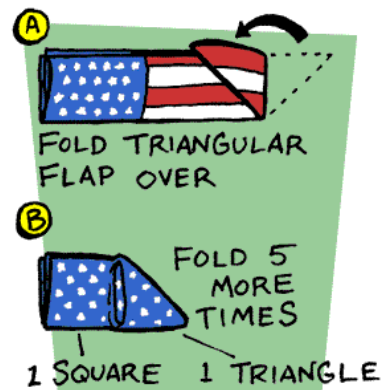


Now fold the flag in a series of triangles. To do it scrupulously correct, you've got to start the folding at a specific point. Start at the striped end of your rectangle. Take the corner of the closed side and bring it diagonally over to the open side, forming a triangular flap.

Step 4: Continue cornering

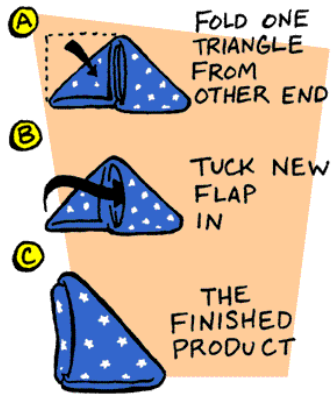
You've created a most unharmonious shape at this point: a long, rectangular shape with a corner lopped off. Take the pointy corner and fold it down, over the other triangular fold, to create a straight edge once again. Now repeat this folding process, switching corners with each fold, until just a blue square of the union is peeking out from the triangular fold.

Only one person does this triangular folding; your partner ceremoniously and patiently holds the other end (ensuring that it doesn't touch the floor!).



Step 5: Master the Final Fold and Tuck

All you've got left is the final fold--the tricky turn that some argue is at the crux of the whole operation. Instead of you folding the thick triangle of folded flag fabric over the last remaining blue square, your partner--who has waited for you so patiently--finally gets to do some creasing. The person on the union end of the flag will take the corner on the open leg and fold it down along the edge of the other leg to form a triangle. He or she then tucks the remaining blue tab under the folds of the thick triangle until the flag is a neat triangle and can't easily unravel.



Using the American flag example, what we will try to demonstrate is that you can think of knowledge about how things work as arranged along a continuum, which we can represent as a seven-point scale.

<1 2 3 4 5 6 7>

For the flag, many people are probably close to a 1, such as the hypothetical person who would not give detailed instructions. Others are close to a 4, such as the hypothetical person who only knew some of the steps, and some, such as a person who would know all of the flag-folding steps are close to a 7.

Note that one does not need to be an expert to have level 7 knowledge – an intelligent, educated lay-person who has read and understood a good description of the procedures in an appropriate reference source probably has level 7 knowledge, as we define it. An expert in a particular phenomenon would almost necessarily have level 7 knowledge, since experts know more than even the most knowledgeable lay-people. Thus, our rating scale is not sensitive to degrees of expert knowledge – the experts know so much they are “off the scale.” The 1-7 scale we described only measures levels of non-expert knowledge.

Instructions

In this experiment you will rate how well you feel you understand certain procedures. We'll ask you to rate your understanding on a seven-point scale.

We are trying to get a sense of how people feel about their understandings of various procedures as part of a larger study of how people make sense of the world. We are going to present you with 14 items; we want you to rate on a 7-point scale how well you feel you understand each one. By "understand" we mean how well you feel that you know how to perform an action and how well you feel like you could explain the instructions to another person. You should give the item close to a "7" if you feel your understanding of the item is excellent, and you should give a "1" if you feel your understanding is very very basic.

There is one tricky part to keep in mind. Some of our participants get confused and think they are rating how well they feel they understand each procedure relative to how well other people understand the same procedure. **That's not your task.** The 7-point scale is meant to be absolute – it does not depend on what you think others may know about each item. In other words, you will be rating how well you feel **you** understand the procedure relative to all other procedures you know. Remember, 7 means you have a very thorough understanding of a procedure, 1 means you have a very vague understanding of the procedure.

Finally, it is very important to give us your **first impression**. We find that taking too long really hurts people's answers. Please go through the list below as quickly as possible and circle the number from 1-7 on the scale next to the item, telling us how well you feel you understand each item.

Rating 1: Distracters & Test (Randomized)

Procedure	Scale								
A correct procedure for how to drive from New Haven to New York City	<	1	2	3	4	5	6	7	>
The correct procedure for how to tie a tie	<	1	2	3	4	5	6	7	>
The correct procedure for how to file your taxes	<	1	2	3	4	5	6	7	>
A correct procedure for how to drive from New Haven to Chicago	<	1	2	3	4	5	6	7	>
A correct procedure for how to make scrambled eggs	<	1	2	3	4	5	6	7	>
The correct procedure for how to set a table	<	1	2	3	4	5	6	7	>
A correct procedure for how to make pasta	<	1	2	3	4	5	6	7	>
The correct procedure for how to tie a bowtie	<	1	2	3	4	5	6	7	>
The correct procedure for how to make an international telephone call	<	1	2	3	4	5	6	7	>
A correct procedure for how to make chocolate chip cookies from scratch	<	1	2	3	4	5	6	7	>

Write Explanations

Now, we'd like to probe your knowledge in a little more detail on some of the items. For each of the following, please describe all the steps in the procedure that you know, going from the first step to the last. For each procedure, try to tell as complete a story as you can, with no gaps.

If you find that your story does have gaps (that is, you are not sure about some of the steps or how they are connected) please write the word "GAP" in your description at that point, and then continue. Feel free to use labeled diagrams, or flow-charts to get your meaning across.

When you are done, please re-rate your knowledge of the procedures on a 1-7 scale in the space provided.

Explain how to drive from New Haven to New York City.

Now, please rate how well you feel you understand this procedure.

A correct procedure for how to drive from New Haven to New York City	<	1	2	3	4	5	6	7	>
--	---	---	---	---	---	---	---	---	---

Explain the correct procedure for how to tie a bowtie.

Now, please rate how well you feel you understand this procedure.

The correct procedure for how to tie a bowtie	<	1	2	3	4	5	6	7	>
---	---	---	---	---	---	---	---	---	---

Explain how to how to make pasta.

Now, please rate how well you feel you understand this procedure.

A correct procedure for how to make pasta	<	1	2	3	4	5	6	7	>
---	---	---	---	---	---	---	---	---	---

Explain how to make an international telephone call.

Now, please rate how well you feel you understand this procedure.

The correct procedure for how to make an international telephone call	<	1	2	3	4	5	6	7	>
---	---	---	---	---	---	---	---	---	---

Explain how to make chocolate chip cookies from scratch.

Now, please rate how well you feel you understand this procedure.

A correct procedure for how to make chocolate chip cookies from scratch	<	1	2	3	4	5	6	7	>
---	---	---	---	---	---	---	---	---	---

Now please rate how well you feel you understand five additional procedures:

Procedure	Scale								
The correct procedure for how to tie a tie	<	1	2	3	4	5	6	7	>
The correct procedure for how to file your taxes	<	1	2	3	4	5	6	7	>
A correct procedure for how to drive from New Haven to Chicago	<	1	2	3	4	5	6	7	>
A correct procedure for how to make scrambled eggs	<	1	2	3	4	5	6	7	>
The correct procedure for how to set a table	<	1	2	3	4	5	6	7	>

Read Expert Explanations

Below you will find the explanations of each procedure provided by an expert. Let's assume that the expert explanations and the diagrams represent Level 7 knowledge. Please read each explanation carefully, and re-rate your initial level of understanding of each explained item, i.e. your level of understanding before you read the explanation. Then, rate your current level of understanding of the explained item, i.e. how well you feel you understand the procedure after you've read the explanation.

How To Drive from New Haven to New York City

Please read the explanation provided by an expert.

How well do you feel you understood the procedure before reading the explanation?

A correct procedure for how to drive from New Haven to New York City	<	1	2	3	4	5	6	7	>
--	---	---	---	---	---	---	---	---	---

How well do you feel you understand the procedure after reading the explanation?

A correct procedure for how to drive from New Haven to New York City	<	1	2	3	4	5	6	7	>
--	---	---	---	---	---	---	---	---	---

How To Tie a Bowtie

Please read the explanation provided by an expert.

How well do you feel you understood the procedure before reading the explanation?

The correct procedure for how to tie a bowtie	<	1	2	3	4	5	6	7	>
---	---	---	---	---	---	---	---	---	---

How well do you feel you understand the procedure after reading the explanation?

The correct procedure for how to tie a bowtie	<	1	2	3	4	5	6	7	>
---	---	---	---	---	---	---	---	---	---

How To Make Pasta

Please read the explanation provided by an expert.

How well do you feel you understood the procedure before reading the explanation?

A correct procedure for how to make pasta	<	1	2	3	4	5	6	7	>
---	---	---	---	---	---	---	---	---	---

How well do you feel you understand the procedure after reading the explanation?

A correct procedure for how to make pasta	<	1	2	3	4	5	6	7	>
---	---	---	---	---	---	---	---	---	---

How To Make International Phone Calls

Please read the explanation provided by an expert.

How well do you feel you understood the procedure before reading the explanation?

The correct procedure for how to make an international telephone call	<	1	2	3	4	5	6	7	>
---	---	---	---	---	---	---	---	---	---

How well do you feel you understand the procedure after reading the explanation?

The correct procedure for how to make an international telephone call	<	1	2	3	4	5	6	7	>
---	---	---	---	---	---	---	---	---	---

How To Make Chocolate Chip Cookies

Please read the explanation provided by an expert.

How well do you feel you understood the procedure before reading the explanation?

A correct procedure for how to make chocolate chip cookies from scratch	<	1	2	3	4	5	6	7	>
---	---	---	---	---	---	---	---	---	---

How well do you feel you understand the procedure after reading the explanation?

A correct procedure for how to make chocolate chip cookies from scratch	<	1	2	3	4	5	6	7	>
---	---	---	---	---	---	---	---	---	---

Now please rate how well you feel you understand five additional procedures:

Procedure	Scale								
The correct procedure for how to tie a tie	<	1	2	3	4	5	6	7	>
The correct procedure for how to file your taxes	<	1	2	3	4	5	6	7	>
A correct procedure for how to drive from New Haven to Chicago	<	1	2	3	4	5	6	7	>
A correct procedure for how to make scrambled eggs	<	1	2	3	4	5	6	7	>
The correct procedure for how to set a table	<	1	2	3	4	5	6	7	>

* Stimuli used in Study 9.

Subject Number	Gender	Year in School

Introduction

In this experiment you will rate how well you feel you know different movie plots. We'll ask you to rate your knowledge on a seven-point scale. Before you get started, this introduction will try to explain what the scores on the scale are supposed to reflect.

Consider all the movies you have seen. You know plots of some of the movies better than others. Here, we will try to explain how you can rate your own knowledge of a particular movie plot on a seven-point scale like the one below.

<1 2 3 4 5 6 7>

For some movies that I have seen (especially those I have seen a long time ago or those I paid little attention to), I have very little knowledge of the plot. For example, if you asked me how well I know the plot of Good Will Hunting. I would have to say "Not very well." If you asked me to explain the plot, I would not be able to say very much. I might know that it was a story about a young man (played by Matt Damon) who works as a janitor at MIT, but can solve complicated math problems. In that case, I'd rate my understanding as a "1."

On the other hand, if I found Good Will Hunting especially engaging, even though I had last seen it years ago, I might have a much better understanding of the plot today. In addition to the above facts, I might also know that the movie was a kind of coming-of-age story and that Robyn Williams played a tough-minded and complicated therapist who helps Will deal with his problems. I might know that a mathematics professor who admires Will's talent tracks him down. I might also know that Will is torn between his love for his friends, and the security their loyalty represents, and the call of the wider world. I might also know that Minnie Driver played a Harvard co-ed with whom Will develops a relationship which is later threatened by Will's problems. Yet, I would not be able to tell you much about the plot beyond that. I would rate that kind of understanding at about a "4" on the 7-point scale.

Suppose, however, that I was interested enough in Good Will Hunting so that I had seen it several times, or that I had talked about the details of the plot with my friends. In that case, I might have an excellent understanding of the plot. That is, I could tell you how all the characters interact within the various settings, and describe the dramatic tension that drives each stage of the movie. When asked about the plot of Good Will Hunting, I might be able to tell you something like the following:

"Good Will Hunting is a story of a young man's struggle to transcend his impoverished and abusive childhood, to discover his place in the world, and to achieve intimacy with others. The main character, Will (the title is a play on his name), is a tough and exceptionally gifted orphan from Boston's South Side who works as a janitor at MIT and cannot resist displaying anonymously his solutions to baffling mathematical problems.

"At twenty, Will Hunting (played by Matt Damon) is brilliant, but troubled. Able to solve complex mathematical problems, Will's intellectual talents are larger-than-life. However, he is leading a life of a street-tough South Boston working-class local: he spends his days working as a janitor and his nights drinking and partying with his buddies Chuckie (played by Ben Affleck), Morgan, and Billy. In the course of his carousing, Will cuts down an obnoxious Harvard graduate student to intellectual size, and inadvertently impresses a beautiful and interesting Harvard co-ed named Skylar (played by Minnie Driver).

"While working as a janitor at MIT, Will delights in anonymously proving theorems on the math building's hall blackboards that a renowned professor – Lambeau – posted as challenges for his students. Then, one evening, his anonymity is shattered when Professor Lambeau catches him at work. Will flees, but Lambeau discovers the identity the mystery genius just about the time that Will is arraigned for his part in a street brawl.

"Impressed by Will's talent, but distraught by his difficult qualities, Lambeau goes out on a limb and arranges for Will to be let out under his supervision. The judge agrees to

release Will under two conditions: that he spend one day a week meeting with Lambeau and that he spend one day a week meeting with a therapist.

“After Will’s belligerent brilliance scares off other therapists, Lambeau turns to Sean McGuire (Robin Williams), his former college roommate and now a professor of psychology at a small local school. Lambeau and Sean hint at a complex relationship: Sean believes Lambeau looks down on him for not living up to the promise of his young talent. Sean chose love over academic glory, but the woman he loves, his wife, recently died from cancer.

“Will remains difficult and pugnacious, forcing Sean to confront the pain in his own life in order to deal with Will. Just as stubborn as Will (and from a similar background), Sean works hard to get inside the prodigy's head. In the course of their struggle Sean becomes a friend and unexpected ally to Will, helping him fend off demands on his talent (presented as an array of fabulous job offers) made by Lambeau.

“Will’s friends seem at first an obstacle to Will’s growth – they give Will the comfort and security he seeks by staying in his old neighborhood and playing familiar working-class roles. They are loyal to Will, but Chuckie eventually tells Will that he’d be a fool to throw away his chance at getting out of South Boston.

“As Will’s romance with Skylar evolves, his obscuring of his past, his unwillingness to face a future, and his difficulty with trust and intimacy become an insurmountable obstacle. An emotional fight leads to break-up. Skylar has to leave Boston imminently for the West Coast, to continue her medical education at Stanford. She tells Will she loves him, and asks him to come with her, but to no effect.

“In the slightly ambiguous ending, Will’s friends give Will something of great value to them – a beat up old car. Will finally leaves South Boston in the car to go to California to be with Skylar, assuming she still wants him. What he will do when he gets to Stanford is uncertain.”

If I knew all or most of the above, I would rate my understanding of Good Will Hunting as a “7” on the 7-point scale.

Instructions

We are trying to get a sense of how people feel about their knowledge of various movie plots as part of a larger study of how people make sense of the world. We are going to present you with 20 movies. For each movie we will ask you (1) whether you have seen the movie, and (2) if you have seen the movie, to rate on a 7-point scale how well you feel you know the plot of the movie. The 7-point scale is based on the description above. That is, you should give the item close to a "1" if you feel know very little about the plot, and close to a "7" if you feel you know almost everything important about the plot.

Finally, it's very important to give us your **first impression**. We find that taking too long really hurts people's answers.

Please go through the list below as quickly as possible and

- Circle "yes" or "no" to indicate whether you have seen each movie
- Circle the number from 1-7 on the scale next to each movie you have seen, telling us how well you feel you know the plot of each movie.

Please indicate if you have seen each of these movies by circling either **Y** for Yes or **N** for No

Movie Plot	Have you seen this movie?	IF YOU HAVE SEEN THE MOVIE, please rate how well you feel you know the plot of the movie. (1=very poor, 7=excellent)
American Beauty	Y N	<1 2 3 4 5 6 7>
The Spy Who Shagged Me	Y N	<1 2 3 4 5 6 7>
Analyze This	Y N	<1 2 3 4 5 6 7>
Armageddon	Y N	<1 2 3 4 5 6 7>
The Wedding Singer	Y N	<1 2 3 4 5 6 7>
American Pie	Y N	<1 2 3 4 5 6 7>
The Phantom Menace	Y N	<1 2 3 4 5 6 7>
Saving Private Ryan	Y N	<1 2 3 4 5 6 7>
The Matrix	Y N	<1 2 3 4 5 6 7>
Titanic	Y N	<1 2 3 4 5 6 7>
Enemy of the State	Y N	<1 2 3 4 5 6 7>
The Truman Show	Y N	<1 2 3 4 5 6 7>
A Civil Action	Y N	<1 2 3 4 5 6 7>
The X Files	Y N	<1 2 3 4 5 6 7>
The Sixth Sense	Y N	<1 2 3 4 5 6 7>
Lethal Weapon 4	Y N	<1 2 3 4 5 6 7>
You've Got Mail	Y N	<1 2 3 4 5 6 7>

When you are done with the ratings, **please STOP.**
DO NOT go on to the next page until one of the experimenters has come by to give you additional instructions.

Now, we'd like to probe your knowledge in a little more detail on some of the movies. The experimenter has handed you a separate sheet with 4 movies marked as #1-4. Please fill in the title and describe the plot of the 4 movies on the pages below.

For each movie, try to tell as complete a story as you can, with no gaps. If you find that your story does have gaps (that is you can't remember some of the details) please write the word "GAP" in your description at that point, and then continue. When you are done with describing a movie, please re-rate your knowledge of that movie on a 1-7 scale.

Movie #1 Title: _____

Now, please rate how well you feel you know this movie plot.

<1 2 3 4 5 6 7>

Movie #2 Title: _____

Now, please rate how well you feel you know this movie plot.

<1 2 3 4 5 6 7>

Movie #3 Title: _____

Now, please rate how well you feel you know this movie plot.

<1 2 3 4 5 6 7>

Movie #4 Title: _____

Now, please rate how well you feel you know this movie plot.

<1 2 3 4 5 6 7>

Read Plot Explanations

Please raise your hand and ask the experimenter for a "Plot Explanations Folder" if you haven't received one yet. The folder will contain the explanations of each movie plot provided by "an expert," that is, someone who knows the movie plot very well. Let's assume that the expert explanations represent Level 7 knowledge of the plot. Please read each explanation carefully.

When you are done reading the explanation of each plot, please re-rate your initial level of understanding of that plot, that is, your level of understanding of the plot before you read the explanation. Then, please rate your current level of understanding of that plot, that is, how well you feel you understand the plot after you've read the explanation.

Movie #1 Title: _____

- A. Please read the explanation of the plot provided by an expert.
- B. After you have finished reading the explanation, please answer the two questions below.

How well do you feel you understood the plot before you have read the explanation?

<1 2 3 4 5 6 7>

How well do you feel you understand the plot after you have read the explanation?

<1 2 3 4 5 6 7>

Movie #2 Title: _____

- A. Please read the explanation of the plot provided by an expert.
- B. After you have finished reading the explanation, please answer the two questions below.

How well do you feel you understood the plot before you have read the explanation?

<1 2 3 4 5 6 7>

How well do you feel you understand the plot after you have read the explanation?

<1 2 3 4 5 6 7>

Movie #3 Title: _____

A. Please read the explanation of the plot provided by an expert.

B. After you have finished reading the explanation, please answer the two questions below.

How well do you feel you understood the plot before you have read the explanation?

<1 2 3 4 5 6 7>

How well do you feel you understand the plot after you have read the explanation?

<1 2 3 4 5 6 7>

Movie #4 Title: _____

A. Please read the explanation of the plot provided by an expert.

B. After you have finished reading the explanation, please answer the two questions below.

How well do you feel you understood the plot before you have read the explanation?

<1 2 3 4 5 6 7>

How well do you feel you understand the plot after you have read the explanation?

<1 2 3 4 5 6 7>

FINAL FOLLOW-UP QUESTION:

Have you seen “Good Will Hunting” (the movie described in the instructions)?

Yes No

* Stimuli used in Study 10: item-set A.

Subject Number	Gender	Year in School

Introduction

In this experiment you will rate how well you feel you understand different types of natural phenomena. We'll ask you to rate your knowledge on a seven-point scale. Before you get started, this introduction will try to explain what the scores on the scale are supposed to reflect.

Consider some natural phenomena that you might know about. You know how some of these phenomena work better than you know others. Here, we will try to explain how you can rate your own knowledge of a particular phenomenon on a seven-point scale like the one below.

<1 2 3 4 5 6 7>

Suppose that I knew enough about geysers to have an excellent understanding of the phenomenon. That is, I could tell you how the processes that produce a geyser interact and at how each step leads to the next. When asked about how geysers work, I might be able to tell you something like the following:

“Sometimes ground water penetrates into vertical fissures deep within the earth and accumulates into a liquid column. If the water at the bottom of the column comes in contact with volcanic heat, its temperatures can rise significantly above 100°C – the boiling point of water under normal pressure. However, the pressure exerted by the column of water above raises the boiling point the water at the bottom of the column, so that it will not boil at 100°C. But, as the water at the very bottom of the column becomes even hotter, a part of it will finally turn into steam despite the great pressure of the water column above it. The expanding steam will cause the water column to rise, until some of it overflows onto the surface. Now, this means that there is less water in the column to press down upon the water at the very bottom. So, the pressure at the bottom will be decreased, meaning the

boiling point will be lowered. The result will be that more of the super-hot water will be immediately converted into steam. All that water suddenly turning to steam will blow the whole column of water out of the fissure – and that's how an eruption of the geyser takes place. The process will then repeat with more or less regularity. The length of the cycle depends on how quickly water seeps into the fissure and how quickly the bottom gets heated up."

If I knew all of the above details (or even most of the important ones), I would rate my understanding of how geyser work as a "7" on a 7-point scale. Suppose, however, that I know considerably fewer details about how geysers work. For example, I might be able to say only that: "A geyser occurs when underground water is heated by volcanic rocks. If the water turns into steam underground, this expansion pushes water up and out at the surface. As the water is blasted upward by the rapid expansion of the steam, it gushes out of the ground as a boiling fountain." Yet, I would not be able to tell you much about the details of the phenomena beyond that. I would rate that kind of understanding at about a "4" on the 7-point scale.

Finally, suppose I only had a very limited understanding of how geysers work. If you asked me to explain geysers, all I might know is that "water is somehow heated underground and that pressure makes it shoot upwards." If that's all I knew about how geysers work, I'd rate my understanding as about a "2." And if all I knew was that "something made water shoot up out of the ground," I would rate my understanding of how geysers work as a "1" on the seven-point scale.

Instructions

We are trying to get a sense of how people feel about their knowledge of various phenomena as part of a larger study of how people make sense of the world. We are going to present you with 24 phenomena. For each one we will ask you to rate on a 7-point scale how well you feel you understand the phenomena. The 7-point scale is based on the description above. That is, you should give the item close to a "1" if you feel know very little about the phenomenon, and close to a "7" if you feel you know almost everything important about the phenomenon.

Finally, it's very important to give us your **first impression**. We find that taking too long really hurts people's answers.

Please go through the list below and circle the number from 1-7 on the scale next to each natural phenomenon, telling us how well you feel you understand each phenomenon.

Remember, "7" means you have a very thorough understanding of a phenomenon, "1" means you have a very vague understanding of the phenomenon.

Phenomena	Scale
Why ice floats in water	< 1 2 3 4 5 6 7 >
Why the earth is round	< 1 2 3 4 5 6 7 >
How thunder forms	< 1 2 3 4 5 6 7 >
Why the sky is blue	< 1 2 3 4 5 6 7 >
How hurricanes form	< 1 2 3 4 5 6 7 >
How cloud-to-ground lightning occurs	< 1 2 3 4 5 6 7 >
Why storm clouds are very dark in color	< 1 2 3 4 5 6 7 >
Why stars twinkle	< 1 2 3 4 5 6 7 >
Why there are seasons	< 1 2 3 4 5 6 7 >
Why the moon has phases	< 1 2 3 4 5 6 7 >
How the ozone layer prevents some UV rays from reaching the earth	< 1 2 3 4 5 6 7 >
Why air bubbles in the water are spherical	< 1 2 3 4 5 6 7 >
How snow forms	< 1 2 3 4 5 6 7 >
How earthquakes occur	< 1 2 3 4 5 6 7 >
How tides occur	< 1 2 3 4 5 6 7 >
Why comets have tails	< 1 2 3 4 5 6 7 >
How clouds are formed	< 1 2 3 4 5 6 7 >
Why sunny days can be colder than cloudy days	< 1 2 3 4 5 6 7 >
How rainbows are formed	< 1 2 3 4 5 6 7 >
Why bubbles have color	< 1 2 3 4 5 6 7 >
Why ice melts faster in water than in air	< 1 2 3 4 5 6 7 >
How hail is formed	< 1 2 3 4 5 6 7 >
How volcanoes erupt	< 1 2 3 4 5 6 7 >
Why frost is produced at night	< 1 2 3 4 5 6 7 >

Write Explanations

Now, we'd like to probe your knowledge in a little more detail on some of the items. For each of the following, please describe all the details you know about the phenomena, going from the first step to the last, and providing the connection between the steps. That is, your explanation should state precisely how each step leads to the next step in one continuous chain from start to finish. In other words, for each phenomenon, try to tell as complete a story as you can, with no gaps.

If you find that your story does have gaps (that is, you are not sure how the steps are connected) please write the word “GAP” in your description at that point, and then continue with the rest of your description. Feel free to use labeled diagrams, or flow-charts to get your meaning across.

Explain why the sky is blue.

Now, please rate how well you feel you understand this phenomenon.

Why the sky is blue	< 1 2 3 4 5 6 7 >
---------------------	-------------------

Explain why the moon has phases.

Now, please rate how well you feel you understand this phenomenon.

Why the moon has phases	< 1 2 3 4 5 6 7 >
-------------------------	-------------------

Explain why comets have tails.

Now, please rate how well you feel you understand this phenomenon.

Why comets have tails	< 1 2 3 4 5 6 7 >
-----------------------	-------------------

Explain how rainbows are formed.

Now, please rate how well you feel you understand this phenomenon.

How rainbows are formed	< 1 2 3 4 5 6 7 >
-------------------------	-------------------

Explain how clouds are formed.

Now, please rate how well you feel you understand this phenomenon.

How clouds are formed.	< 1 2 3 4 5 6 7 >
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Answer Specific Questions

In this section, we will probe your knowledge a little further, by asking you to describe specific aspects of the phenomena. Please try to answer each of the questions below in as much detail as you can.

Why does the sky change color only during sunset?

Now, please rate how well you feel you understand this phenomenon.

Why the sky is blue	< 1 2 3 4 5 6 7 >
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Why does the moon sometimes rise before the sunset and sometimes after the sunset?

Now, please rate how well you feel you understand this phenomenon.

Why the moon has phases	< 1 2 3 4 5 6 7 >
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Why does a comet's tail always point away from the sun?

Now, please rate how well you feel you understand this phenomenon.

Why comets have tails	< 1 2 3 4 5 6 7 >
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Why do rainbows always have the colors in the same order?

Now, please rate how well you feel you understand this phenomenon.

How rainbows are formed	< 1 2 3 4 5 6 7 >
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What makes clouds actually retain their shape rather than just drift apart?

Now, please rate how well you feel you understand this phenomenon.

How clouds are formed	< 1 2 3 4 5 6 7 >
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Read Expert Explanations

Below you will find the explanations of each phenomenon provided by an expert. Let's assume that the expert explanations and the diagrams represent Level 7 knowledge. Please read each explanation carefully, and re-rate your initial level of understanding of each explained item (that is, your level of understanding before you read the explanation), and also your current level of understanding of the explained item (that is, how well you feel you understand the phenomenon after you've read the explanation).

Blue Sky

Please read the explanation in folder 1.

How well did you understand the phenomenon before you had read the explanation?

Why the sky is blue	< 1 2 3 4 5 6 7 >
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How well do you understand the phenomenon now that you have read the explanation?

Why the sky is blue	< 1 2 3 4 5 6 7 >
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Moon Phases

Please read the explanation in folder 4.

How well did you understand the phenomenon before you had read the explanation?

Why the moon has phases	< 1 2 3 4 5 6 7 >
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How well do you understand the phenomenon now that you have read the explanation?

Why the moon has phases	< 1 2 3 4 5 6 7 >
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Comet Tails

Please read the explanation in folder 3.

How well did you understand the phenomenon before you had read the explanation?

Why comets have tails	< 1 2 3 4 5 6 7 >
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How well do you understand the phenomenon now that you have read the explanation?

Why comets have tails	< 1 2 3 4 5 6 7 >
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Rainbows

Please read the explanation in folder 4.

How well did you understand the phenomenon before you had read the explanation?

How rainbows are formed	< 1 2 3 4 5 6 7 >
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How well do you understand the phenomenon now that you have read the explanation?

How rainbows are formed	< 1 2 3 4 5 6 7 >
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Clouds

Please read the explanation in folder 4.

How well did you understand the phenomenon before you had read the explanation?

How clouds are formed.	< 1 2 3 4 5 6 7 >
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How well do you understand the phenomenon now that you have read the explanation?

How clouds are formed.	< 1 2 3 4 5 6 7 >
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* Stimuli used in Study 10: item-set B.

Subject Number	Gender	Year in School

Introduction

In this experiment you will rate how well you feel you understand different types of natural phenomena. We'll ask you to rate your knowledge on a seven-point scale. Before you get started, this introduction will try to explain what the scores on the scale are supposed to reflect.

Consider some natural phenomena that you might know about. You know how some of these phenomena work better than you know others. Here, we will try to explain how you can rate your own knowledge of a particular phenomenon on a seven-point scale like the one below.

<1 2 3 4 5 6 7>

Suppose that I knew enough about geysers to have an excellent understanding of the phenomenon. That is, I could tell you how the processes that produce a geyser interact and at how each step leads to the next. When asked about how geysers work, I might be able to tell you something like the following:

“Sometimes ground water penetrates into vertical fissures deep within the earth and accumulates into a liquid column. If the water at the bottom of the column comes in contact with volcanic heat, its temperatures can rise significantly above 100°C – the boiling point of water under normal pressure. However, the pressure exerted by the column of water above raises the boiling point the water at the bottom of the column, so that it will not boil at 100°C. But, as the water at the very bottom of the column becomes even hotter, a part of it will finally turn into steam despite the great pressure of the water column above it. The expanding steam will cause the water column to rise, until some of it overflows onto the surface. Now, this means that there is less water in the column to press down upon the water at the very bottom. So, the pressure at the bottom will be decreased, meaning the boiling point will be lowered. The result will be that more of the super-hot water will be immediately converted into steam. All that water suddenly turning to steam will blow the whole column of water out of the fissure – and that’s how an eruption of the geyser takes place. The process will then repeat with more or less regularity.

The length of the cycle depends on how quickly water seeps into the fissure and how quickly the bottom gets heated up.”

If I knew all of the above details (or even most of the important ones), I would rate my understanding of how geyser work as a “7” on a 7-point scale. Suppose, however, that I know considerably fewer details about how geysers work. For example, I might be able to say only that: “A geyser occurs when underground water is heated by volcanic rocks. If the water turns into steam underground, this expansion pushes water up and out at the surface. As the water is blasted upward by the rapid expansion of the steam, it gushes out of the ground as a boiling fountain.” Yet, I would not be able to tell you much more about the details of the phenomena beyond that. I would rate that kind of understanding at about a “4” on the 7-point scale.

Finally, suppose I only had a very limited understanding of how geysers work. If you asked me to explain geysers, all I might know is that “water is somehow heated underground and that pressure makes it shoot upwards.” If that’s all I knew about how geysers work, I’d rate my understanding as about a “2.” And if all I knew was that “something made water shoot up out of the ground,” I would rate my understanding of how geysers work as a “1” on the seven-point scale.

Instructions

We are trying to get a sense of how people feel about their knowledge of various phenomena as part of a larger study of how people make sense of the world. We are going to present you with 24 phenomena. For each one we will ask you to rate on a 7-point scale how well you feel you understand the phenomena. The 7-point scale is based on the description above. That is, you should give the item close to a "1" if you feel know very little about the phenomenon, and close to a "7" if you feel you know almost everything important about the phenomenon.

Finally, it's very important to give us your **first impression**. We find that taking too long really hurts people's answers.

Please go through the list below and circle the number from 1-7 on the scale next to each natural phenomenon, telling us how well you feel you understand each phenomenon.

Remember, "7" means you have a very thorough understanding of a phenomenon, "1" means you have a very vague understanding of the phenomenon.

Phenomena	Scale
Why ice floats in water	< 1 2 3 4 5 6 7 >
Why the earth is round	< 1 2 3 4 5 6 7 >
How thunder forms	< 1 2 3 4 5 6 7 >
Why the sky is blue	< 1 2 3 4 5 6 7 >
How hurricanes form	< 1 2 3 4 5 6 7 >
How cloud-to-ground lightning occurs	< 1 2 3 4 5 6 7 >
Why storm clouds are very dark in color	< 1 2 3 4 5 6 7 >
Why stars twinkle	< 1 2 3 4 5 6 7 >
Why there are seasons	< 1 2 3 4 5 6 7 >
Why the moon has phases	< 1 2 3 4 5 6 7 >
How the ozone layer prevents some UV rays from reaching the earth	< 1 2 3 4 5 6 7 >
Why air bubbles in the water are spherical	< 1 2 3 4 5 6 7 >
How snow forms	< 1 2 3 4 5 6 7 >
How earthquakes occur	< 1 2 3 4 5 6 7 >
How tides occur	< 1 2 3 4 5 6 7 >
Why comets have tails	< 1 2 3 4 5 6 7 >
How clouds are formed	< 1 2 3 4 5 6 7 >
Why sunny days can be colder than cloudy days	< 1 2 3 4 5 6 7 >
How rainbows are formed	< 1 2 3 4 5 6 7 >
Why bubbles have color	< 1 2 3 4 5 6 7 >
Why ice melts faster in water than in air	< 1 2 3 4 5 6 7 >
How hail is formed	< 1 2 3 4 5 6 7 >
How volcanoes erupt	< 1 2 3 4 5 6 7 >
Why frost is produced at night	< 1 2 3 4 5 6 7 >

Write Explanations

Now, we'd like to probe your knowledge in a little more detail on some of the items. For each of the following, please describe all the details you know about the phenomena, going from the first step to the last, and providing the connection between the steps. That is, your explanation should state precisely how each step leads to the next step in one continuous chain from start to finish. In other words, for each phenomenon, try to tell as complete a story as you can, with no gaps.

If you find that your story does have gaps (that is, you are not sure how the steps are connected) please write the word “GAP” in your description at that point, and then continue with the rest of your description. Feel free to use labeled diagrams, or flow-charts to get your meaning across.

Explain how thunder forms.

Now, please rate how well you feel you understand this phenomenon.

How thunder forms	< 1 2 3 4 5 6 7 >
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Explain why there are seasons.

Now, please rate how well you feel you understand this phenomenon.

Why there are seasons	< 1 2 3 4 5 6 7 >
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Explain how earthquakes occur.

Now, please rate how well you feel you understand this phenomenon.

How earthquakes occur	< 1 2 3 4 5 6 7 >
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Explain how tides occur.

Now, please rate how well you feel you understand this phenomenon.

How tides occur	< 1 2 3 4 5 6 7 >
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Explain why bubbles have colors.

Now, please rate how well you feel you understand this phenomenon.

Why bubbles have colors	< 1 2 3 4 5 6 7 >
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Answer Specific Questions

In this section, we will probe your knowledge a little further, by asking you to describe specific aspects of the phenomena. Please try to answer each of the questions below in as much detail as you can.

Why do we hear prolonged rumbles of thunder although lightning comes in a single flash?

Now, please rate how well you feel you understand this phenomenon.

How thunder forms	< 1 2 3 4 5 6 7 >
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Why are the seasons in the Southern Hemisphere at opposite times of the year than in the Northern Hemisphere?

Now, please rate how well you feel you understand this phenomenon.

Why there are seasons	< 1 2 3 4 5 6 7 >
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Why are earthquakes more frequent in certain parts of the world?

Now, please rate how well you feel you understand this phenomenon.

How earthquakes occur	< 1 2 3 4 5 6 7 >
-----------------------	-------------------

Why are there two high tides every day?

Now, please rate how well you feel you understand this phenomenon.

How tides occur	< 1 2 3 4 5 6 7 >
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Why are thicker bubbles more colorful than thinner bubbles?

Now, please rate how well you feel you understand this phenomenon.

Why bubbles have colors	< 1 2 3 4 5 6 7 >
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Read Expert Explanations

Below you will find the explanations of each phenomenon provided by an expert. Let's assume that the expert explanations and the diagrams represent Level 7 knowledge. Please read each explanation carefully, and re-rate your initial level of understanding of each explained item (that is, your level of understanding before you read the explanation), and also your current level of understanding of the explained item (that is, how well you feel you understand the phenomenon after you've read the explanation).

Thunder

Please read the explanation in folder B1.

How well did you understand the phenomenon before you had read the explanation?

How thunder forms	< 1 2 3 4 5 6 7 >
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How well do you understand the phenomenon now that you have read the explanation?

How thunder forms	< 1 2 3 4 5 6 7 >
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Seasons

Please read the explanation in folder B2.

How well did you understand the phenomenon before you had read the explanation?

Why there are seasons	< 1 2 3 4 5 6 7 >
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How well do you understand the phenomenon now that you have read the explanation?

Why there are seasons	< 1 2 3 4 5 6 7 >
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Earthquakes

Please read the explanation in folder B3.

How well did you understand the phenomenon before you had read the explanation?

How earthquakes occur	< 1 2 3 4 5 6 7 >
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How well do you understand the phenomenon now that you have read the explanation?

How earthquakes occur	< 1 2 3 4 5 6 7 >
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Tides

Please read the explanation in folder B4.

How well did you understand the phenomenon before you had read the explanation?

How tides occur	< 1 2 3 4 5 6 7 >
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How well do you understand the phenomenon now that you have read the explanation?

How tides occur	< 1 2 3 4 5 6 7 >
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Bubbles

Please read the explanation in folder 4.

How well did you understand the phenomenon before you had read the explanation?

Why bubbles have colors	< 1 2 3 4 5 6 7 >
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How well do you understand the phenomenon now that you have read the explanation?

Why bubbles have colors	< 1 2 3 4 5 6 7 >
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* Stimuli used in Study 11. Half of the Study 11 participants received this version of the stimuli, and the other half received a version with the items in the reverse order.

Participant #:	Gender:	Year in College:	Major:

Instructions

On the next few pages you will find a list of items. Each item will describe something that a person might know.

For each item, please rate **how embarrassed you think you would be if someone asked you to explain that item and it turned out that you did not have a good understanding or knowledge of that item.**

You will rate the items on a 7-point scale like the one below:

	<1	2	3	4	5	6	7>	
not at all embarrassed								very embarrassed

“1” on the scale means “I would not be at all embarrassed if it turned out that I did not have a good understanding or knowledge of this item.”

“7” on the scale means “I would be very embarrassed if it turned out that I did not have a good understanding or knowledge of this item.”

<i>Item</i>	How embarrassed? 1 = not at all 7 = very
Why the sky is blue	<1 2 3 4 5 6 7>
How a fluorescent light works	<1 2 3 4 5 6 7>
The capital city of Uzbekistan	<1 2 3 4 5 6 7>
How piano keys make sounds	<1 2 3 4 5 6 7>
The capital city of Benin	<1 2 3 4 5 6 7>
How a computer mouse controls the pointer on a computer screen	<1 2 3 4 5 6 7>
How a snare catches small animals	<1 2 3 4 5 6 7>
The capital city of Japan	<1 2 3 4 5 6 7>
A correct procedure for how to make chocolate chip cookies from scratch	<1 2 3 4 5 6 7>
How a manual clutch works	<1 2 3 4 5 6 7>
How a transistor works	<1 2 3 4 5 6 7>
The plot of Saving Private Ryan (assume you saw the movie)	<1 2 3 4 5 6 7>
The correct procedure for how to tie a tie	<1 2 3 4 5 6 7>
The plot of You've Got Mail (assume you saw the movie)	<1 2 3 4 5 6 7>
The capital city of China	<1 2 3 4 5 6 7>
How a car's gearbox works	<1 2 3 4 5 6 7>
How a self-winding watch runs without batteries	<1 2 3 4 5 6 7>
How a spray-bottle sprays liquids	<1 2 3 4 5 6 7>
The plot of American Beauty (assume you saw the movie)	<1 2 3 4 5 6 7>
The capital city of Iran	<1 2 3 4 5 6 7>
How rainbows are formed	<1 2 3 4 5 6 7>
A correct procedure for how to make scrambled eggs	<1 2 3 4 5 6 7>

How a radio receiver works	<1 2 3 4 5 6 7>
The plot of Enemy of the State (assume you saw the movie)	<1 2 3 4 5 6 7>
The capital city of Egypt	<1 2 3 4 5 6 7>
The plot of Lethal Weapon 4 (assume you saw the movie)	<1 2 3 4 5 6 7>
How tides occur	<1 2 3 4 5 6 7>
The correct procedure for how to make pasta	<1 2 3 4 5 6 7>
How a sewing machine works	<1 2 3 4 5 6 7>
How a solid-fuel rocket produces thrust	<1 2 3 4 5 6 7>
The plot of Star Wars Episode I: The Phantom Menace (assume you saw the movie)	<1 2 3 4 5 6 7>
The capital city of Australia	<1 2 3 4 5 6 7>
How a hydroelectric turbine changes water pressure into electricity	<1 2 3 4 5 6 7>
How a zipper works	<1 2 3 4 5 6 7>
The plot of Armageddon (assume you saw the movie)	<1 2 3 4 5 6 7>
The correct procedure for how to set a table	<1 2 3 4 5 6 7>
How a scanner captures images	<1 2 3 4 5 6 7>
How earthquakes occur	<1 2 3 4 5 6 7>
How an incinerator works	<1 2 3 4 5 6 7>
How a water faucet controls water flow	<1 2 3 4 5 6 7>
The plot of The X Files Movie (assume you saw the movie)	<1 2 3 4 5 6 7>
How a helicopter flies	<1 2 3 4 5 6 7>
The plot of The Wedding Singer (assume you saw the movie)	<1 2 3 4 5 6 7>
How clouds are formed	<1 2 3 4 5 6 7>
A correct procedure for how to drive from New Haven to New York City	<1 2 3 4 5 6 7>
Why comets have tails	<1 2 3 4 5 6 7>

How thunder forms	<1 2 3 4 5 6 7>
How a cellular phone works	<1 2 3 4 5 6 7>
The capital city of Canada	<1 2 3 4 5 6 7>
The capital city of Norway	<1 2 3 4 5 6 7>
The correct procedure for how to file your taxes	<1 2 3 4 5 6 7>
The capital city of Bolivia	<1 2 3 4 5 6 7>
Why bubbles have color	<1 2 3 4 5 6 7>
The plot of The Matrix (assume you saw the movie)	<1 2 3 4 5 6 7>
The capital city of India	<1 2 3 4 5 6 7>
The capital city of Bulgaria	<1 2 3 4 5 6 7>
Why there are seasons	<1 2 3 4 5 6 7>
How a television creates pictures	<1 2 3 4 5 6 7>
How a VCR works	<1 2 3 4 5 6 7>
How a greenhouse works	<1 2 3 4 5 6 7>
How a fireplace works	<1 2 3 4 5 6 7>
How a can opener works	<1 2 3 4 5 6 7>
The capital city of Kyrgyzstan	<1 2 3 4 5 6 7>
The capital city of Chile	<1 2 3 4 5 6 7>
The plot of Titanic (assume you saw the movie)	<1 2 3 4 5 6 7>
How a microchip processes information	<1 2 3 4 5 6 7>
How a photocopier makes copies	<1 2 3 4 5 6 7>
The capital city of Italy	<1 2 3 4 5 6 7>
How a car battery stores electricity	<1 2 3 4 5 6 7>
The capital city of Burkina Faso	<1 2 3 4 5 6 7>
How a telephone transmits sound through wires	<1 2 3 4 5 6 7>

The plot of The Truman Show (assume you saw the movie)	<1 2 3 4 5 6 7>
How an LCD Screen works	<1 2 3 4 5 6 7>
The plot of The Sixth Sense (assume you saw the movie)	<1 2 3 4 5 6 7>
The capital city of Pakistan	<1 2 3 4 5 6 7>
How a cylinder lock opens with a key	<1 2 3 4 5 6 7>
A correct procedure for how to drive from New Haven to Chicago	<1 2 3 4 5 6 7>
The capital city of Liechtenstein	<1 2 3 4 5 6 7>
How a speedometer works	<1 2 3 4 5 6 7>
How a jet engine produces thrust	<1 2 3 4 5 6 7>
How a car differential helps the car turn	<1 2 3 4 5 6 7>
The correct procedure for how to make an international telephone call	<1 2 3 4 5 6 7>
The capital city of Saudi Arabia	<1 2 3 4 5 6 7>
The plot of Analyze This (assume you saw the movie)	<1 2 3 4 5 6 7>
How an electric motor changes electricity into movement	<1 2 3 4 5 6 7>
The capital city of Germany	<1 2 3 4 5 6 7>
How a car ignition system starts the engine	<1 2 3 4 5 6 7>
The plot of American Pie (assume you saw the movie)	<1 2 3 4 5 6 7>
The capital city of Kazakhstan	<1 2 3 4 5 6 7>
The capital city of Namibia	<1 2 3 4 5 6 7>
Why the moon has phases	<1 2 3 4 5 6 7>
The plot of Austin Powers 2: The Spy Who Shagged Me (assume you saw the movie)	<1 2 3 4 5 6 7>
How a quartz watch keeps time	<1 2 3 4 5 6 7>
The correct procedure for how to tie a bow tie	<1 2 3 4 5 6 7>
How an Ethernet network allows computers to share files	<1 2 3 4 5 6 7>

How a ball-point pen writes	<1 2 3 4 5 6 7>
The capital city of Lesotho	<1 2 3 4 5 6 7>
The plot of A Civil Action (assume you saw the movie)	<1 2 3 4 5 6 7>
How a flush toilet operates	<1 2 3 4 5 6 7>
How the aqua-lung (SCUBA gear) regulates air pressure	<1 2 3 4 5 6 7>
The capital city of United Kingdom	<1 2 3 4 5 6 7>
How a 35mm (single-lens reflex) camera works	<1 2 3 4 5 6 7>
The capital city of Ireland	<1 2 3 4 5 6 7>

* Stimuli used in Study 12a. Half of the Study 11 participants received this version of the stimuli, and the other half received a version with the items in the reverse order.

Subject Number	Gender	Major

General Instructions

This study is one in a series of experiments that examine how people think about what they know. This experiment has several sections. Before completing each section, please read the instructions carefully.

Familiarity

Please rate how familiar you are with the following devices/phenomena.

1 = not at all familiar

7 = very familiar

a zipper	< 1 2 3 4 5 6 7 >
a steam central heating system	< 1 2 3 4 5 6 7 >
a cylinder lock	< 1 2 3 4 5 6 7 >
the aqualung (Scuba-gear)	< 1 2 3 4 5 6 7 >
a cellular phone	< 1 2 3 4 5 6 7 >
a transistor	< 1 2 3 4 5 6 7 >
a can opener	< 1 2 3 4 5 6 7 >
a manual clutch	< 1 2 3 4 5 6 7 >
piano keys	< 1 2 3 4 5 6 7 >
a computer mouse	< 1 2 3 4 5 6 7 >
a telephone	< 1 2 3 4 5 6 7 >
a solid-fuel rocket	< 1 2 3 4 5 6 7 >
a speedometer	< 1 2 3 4 5 6 7 >
a car battery	< 1 2 3 4 5 6 7 >
a microchip	< 1 2 3 4 5 6 7 >
a fireplace	< 1 2 3 4 5 6 7 >
a car ignition system	< 1 2 3 4 5 6 7 >
a fluorescent light	< 1 2 3 4 5 6 7 >
a LCD screen	< 1 2 3 4 5 6 7 >
a VCR	< 1 2 3 4 5 6 7 >
a scanner	< 1 2 3 4 5 6 7 >
a quartz watch	< 1 2 3 4 5 6 7 >
a sewing machine	< 1 2 3 4 5 6 7 >
a greenhouse	< 1 2 3 4 5 6 7 >
a radio receiver	< 1 2 3 4 5 6 7 >
the presidential election process	< 1 2 3 4 5 6 7 >
a nuclear reactor	< 1 2 3 4 5 6 7 >

a jet engine	< 1 2 3 4 5 6 7 >
a spray-bottle	< 1 2 3 4 5 6 7 >
a flush toilet	< 1 2 3 4 5 6 7 >
a television	< 1 2 3 4 5 6 7 >
a car's gearbox	< 1 2 3 4 5 6 7 >
a helicopter	< 1 2 3 4 5 6 7 >
a water faucet	< 1 2 3 4 5 6 7 >
an incinerator	< 1 2 3 4 5 6 7 >
the process by which the US supreme court determines the constitutionality of laws	< 1 2 3 4 5 6 7 >
an electric motor	< 1 2 3 4 5 6 7 >
the human heart	< 1 2 3 4 5 6 7 >
a 35mm camera (Single-Lens Reflex Camera)	< 1 2 3 4 5 6 7 >
an Ethernet network	< 1 2 3 4 5 6 7 >
a photocopier	< 1 2 3 4 5 6 7 >
a car differential	< 1 2 3 4 5 6 7 >
a ball-point pen	< 1 2 3 4 5 6 7 >
the human brain	< 1 2 3 4 5 6 7 >
a hydroelectric turbine	< 1 2 3 4 5 6 7 >
a snare	< 1 2 3 4 5 6 7 >
a self-winding watch without batteries	< 1 2 3 4 5 6 7 >
the human liver	< 1 2 3 4 5 6 7 >

Hidden vs. Visible Parts

Many devices, such as computers, hide almost all of their important working parts inside an outer container. On the other hand, when you use a device like a crossbow, you can clearly see almost all of the parts and how they work together.

For each of the following items, please estimate the proportion of parts that are visible during the normal course of operation

1=most parts hidden

7=most parts visible

a zipper	< 1 2 3 4 5 6 7 >
a steam central heating system	< 1 2 3 4 5 6 7 >
a cylinder lock	< 1 2 3 4 5 6 7 >
the aqualung (Scuba-gear)	< 1 2 3 4 5 6 7 >
a cellular phone	< 1 2 3 4 5 6 7 >
a transistor	< 1 2 3 4 5 6 7 >
a can opener	< 1 2 3 4 5 6 7 >
a manual clutch	< 1 2 3 4 5 6 7 >
piano keys	< 1 2 3 4 5 6 7 >
a computer mouse	< 1 2 3 4 5 6 7 >
a telephone	< 1 2 3 4 5 6 7 >
a solid-fuel rocket	< 1 2 3 4 5 6 7 >
a speedometer	< 1 2 3 4 5 6 7 >
a car battery	< 1 2 3 4 5 6 7 >
a microchip	< 1 2 3 4 5 6 7 >
a fireplace	< 1 2 3 4 5 6 7 >
a car ignition system	< 1 2 3 4 5 6 7 >
a fluorescent light	< 1 2 3 4 5 6 7 >
a LCD screen	< 1 2 3 4 5 6 7 >
a VCR	< 1 2 3 4 5 6 7 >
a scanner	< 1 2 3 4 5 6 7 >

a quartz watch	< 1 2 3 4 5 6 7 >
a sewing machine	< 1 2 3 4 5 6 7 >
a greenhouse	< 1 2 3 4 5 6 7 >
a radio receiver	< 1 2 3 4 5 6 7 >
a nuclear reactor	< 1 2 3 4 5 6 7 >
a jet engine	< 1 2 3 4 5 6 7 >
a spray-bottle	< 1 2 3 4 5 6 7 >
a flush toilet	< 1 2 3 4 5 6 7 >
a television	< 1 2 3 4 5 6 7 >
a car's gearbox	< 1 2 3 4 5 6 7 >
a helicopter	< 1 2 3 4 5 6 7 >
a water faucet	< 1 2 3 4 5 6 7 >
an incinerator	< 1 2 3 4 5 6 7 >
an electric motor	< 1 2 3 4 5 6 7 >
a 35mm camera (Single-Lens Reflex Camera)	< 1 2 3 4 5 6 7 >
an Ethernet network	< 1 2 3 4 5 6 7 >
a photocopier	< 1 2 3 4 5 6 7 >
a car differential	< 1 2 3 4 5 6 7 >
a ball-point pen	< 1 2 3 4 5 6 7 >
a hydroelectric turbine	< 1 2 3 4 5 6 7 >
a snare	< 1 2 3 4 5 6 7 >
a self-winding watch without batteries	< 1 2 3 4 5 6 7 >

Electrical vs. Mechanical Devices

Some devices can be easily classified as either electrical or mechanical, whereas other devices may be some combination of both. For each of the following devices, please rate the degree to which device operates by electrical or mechanical principles.

a zipper	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a steam central heating system	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a cylinder lock	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
the aqualung (Scuba-gear)	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a cellular phone	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a transistor	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a can opener	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a manual clutch	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
piano keys	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a computer mouse	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a telephone	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
solid-fuel rocket	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a speedometer	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a car battery	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a microchip	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a fireplace	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a car ignition system	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a fluorescent light	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a LCD screen	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a VCR	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a scanner	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a quartz watch	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a sewing machine	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a greenhouse	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a radio receiver	(electrical)< 1 2 3 4 5 6 7 >(mechanical)

a nuclear reactor	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a jet engine	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a spray-bottle	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a flush toilet	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a television	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a car's gearbox	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a helicopter	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a water faucet	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
an incinerator	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
an electric motor	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a 35mm camera (Single-Lens Reflex Camera)	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
an Ethernet network	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a photocopier	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a car differential	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a ball-point pen	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a hydroelectric turbine	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a snare	(electrical)< 1 2 3 4 5 6 7 >(mechanical)
a self-winding watch without batteries	(electrical)< 1 2 3 4 5 6 7 >(mechanical)

Number of Parts: Instructions

Every device is made up of a number of different "parts". For example, on one level, a computer is made up of a monitor, mouse, CPU unit, and keyboard. On an even deeper level, the computer is made up of a motherboard, power supply, RAM, hard drive, video card, etc. And every part that was just named is obviously made up of even more parts. While it may be impossible to arrive at an absolute number of parts making up a given device, it is safe to say that certain devices are made up of more parts than others (i.e., a computer has more parts than a toaster.)

We are looking for your subjective estimate of how many parts make up the following items. When you are trying to imagine how many parts something has, it may be helpful to think about how many parts you can disassemble the device into without breaking anything. You can also imagine a blow-up diagram of the item and estimate the number of parts you would see on that diagram.

These pictures of a combination lock and its constituent parts may help illustrate what we mean by a "part."



Number of Parts

Please indicate how many parts you think the following items have:
1-5, 6-10, 11-25, 26-50, 51-100, 101-250, 251-500, 501-1000, or more
than 1000.

a zipper	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a steam central heating system	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a cylinder lock	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
the aqualung (Scuba-gear)	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a cellular phone	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a transistor	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a can opener	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a manual clutch	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
piano keys	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a computer mouse	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a telephone	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a solid-fuel rocket	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a speedometer	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a car battery	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a microchip	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a fireplace	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a car ignition system	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a fluorescent light	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a LCD screen	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a VCR	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a scanner	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a quartz watch	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a sewing machine	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a greenhouse	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a radio receiver	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a nuclear reactor	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >

a jet engine	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a spray-bottle	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a flush toilet	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a television	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a car's gearbox	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a helicopter	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a water faucet	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
an incinerator	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
an electric motor	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a 35mm camera (Single-Lens Reflex Camera)	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
an Ethernet network	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a photocopier	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a car differential	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a ball-point pen	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a hydroelectric turbine	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a snare	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >
a self-winding watch without batteries	< 1-5	6-10	11-25	26-50	51-100	101-250	251-500	501-1000	1001+ >

Names of Parts

How many different parts of the following items would you guess you could identify by name? Please estimate whether you could name:
0, 1-2, 3-5, 6-10, 11-25, 26-50, 51-100, 101-250, or more than 250 parts.

a zipper	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a steam central heating system	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a cylinder lock	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
the aqualung (Scuba-gear)	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a cellular phone	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a transistor	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a can opener	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a manual clutch	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
piano keys	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a computer mouse	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a telephone	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a solid-fuel rocket	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a speedometer	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a car battery	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a microchip	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a fireplace	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a car ignition system	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a fluorescent light	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a LCD screen	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a VCR	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a scanner	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a quartz watch	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a sewing machine	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a greenhouse	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a radio receiver	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a nuclear reactor	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a jet engine	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >

a spray-bottle	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a flush toilet	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a television	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a car's gearbox	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a helicopter	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a water faucet	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
an incinerator	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
an electric motor	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a 35mm camera (Single-Lens Reflex Camera)	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
an Ethernet network	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a photocopier	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a car differential	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a ball-point pen	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a hydroelectric turbine	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a snare	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >
a self-winding watch without batteries	< 0	1-2	3-5	6-10	11-25	26-50	51-100	101-250	251+ >